From a Sketch *by A. Gregory.*

VIEW FROM THE EDGE OF THE VOLCANIC CAULDRON OF LAKE GNOTUK.

Across the Western Plains of Victoria, with the salt bed of Lake Kolungulac and the extinct craters of Kurtweeton and Mount Elephant.

O …RD'S

COMPENDIUM OF GEOGRAPHY AND TRAVEL

(NEW ISSUE)

AUSTRALASIA

VOL. I.

AUSTRALIA AND NEW ZEALAND

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MAPS AND ILLUSTRATIONS

SECOND EDITION, REWRITTEN

LONDON: EDWARD STANFORD

12, 13, & 14, LONG ACRE, W.C.

1907

PREFACE

THIS book endeavours to give a concise account of the physical and economic geography of Australia and New Zealand, including some account of the chief features of their climate, geological structure, aborigines, fauna, and flora. The description of the structural geography has necessitated a somewhat fuller account of the geology than of some of the other branches of the subject. The previous edition of this volume on Australasia in this "Compendium of Geography" was by Dr. A. Russel Wallace, and it was notable, among its many merits, for its advocacy of the Caucasian affinities of the Australian aborigines. During recent years the geographical materials regarding Australia have grown very rapidly, owing to the surveys by the Departments of Lands, Mines, Railways, Water Supply, Public Works, and Agriculture in the different States. It was therefore felt that a revision of the previous edition would not be adequate, and I was asked to prepare a new work. While the work has been passing through the press there have been some important changes, for progress in Australia is rapid. The mining laws of Tasmania, for example, have been completely revised, and greater freedom granted in

reference to the Labour Covenants. New South Wales has also recently altered its mining laws. It was, however, thought better to retain the summaries of the mining laws already in print, from their interest in reference to the development of Australian industrial legislation. The law controlling the immigration of artisan labour under contract (referred to on p. 28) has recently been amended to make its original purpose clear, and remove the misunderstanding of this subject prevalent in Great Britain. Since Chapter I. was in print, there has been a marked change in the British attitude towards Australian naval policy. The view that Australia could give more efficient aid to the Empire by developing her own navy seems to be rapidly spreading in this country. It has been supported, amongst others, by Lord Brassey, Admiral Fitzgerald, and Mr. Richard Jebb. The more sympathetic appreciation of the Australian attitude is the more satisfactory, as discontent with the existing arrangement seems to have been growing rapidly in Australia. A formal guarantee that Australia would not remain neutral should the United Kingdom be engaged in war would probably remove many British objections to the development of an independent Australian fleet; and some of the critics of the British official view do not seem to realise that Australia is under no constitutional necessity to render assistance to the Empire in case of war.

In some recent political discussions in the Federal Parliament, the word "desert" has been used with much vigour. I therefore remark that the word is here used for

an arid unoccupied land. The limitation of the term to arid regions is only a modern modification, which seems, however, now well established. It would hardly be consistent with modern usage to follow Sir Walter Scott (*Waverley*, chap. xv.) in describing the Grampians, with their 80-inch rainfall, as "those pathless deserts." Land may be truly described as desert, without implying that it will always remain desert.

All place names beginning with Mac —— or M'—— have been spelt in full as Mac, beginning the second syllable with a small letter. This system has been adopted after reference to Dr. J. Scott Keltie, with whose approval I feel safe. It is often now impossible to determine how the stockman who first surveyed a country from Mac——'s Look-out, or first watered his flock at Mac——'s Water-hole, preferred to spell his name. When we find two brothers spelling their name, one Macallister and the other M'Allister, geographers may be excused for adopting a uniform spelling of this prefix.

Much light has been recently thrown on the last land connection of Australia with Asia by the great work of the cousins P. and F. Sarasin, *Materialien zur Naturgeschichte der Insel Celebes*; their detailed study of the geological history of Celebes, as shown by the relations of its animals, seems finally to remove the old difficulty of the entrance of the dingo into Australia before the arrival of man.

Some correspondents have lately asked whether, although the Australian aborigines may be Caucasian, they are not in a lower stage of culture than any other

existing people? If the accounts of some tribes in Central South America are to be trusted, they, although living in a stone-bearing land, have no stone tools, but use only shells, thorns, and bones, and are below the grade of Australian aboriginal culture.

I have also been recently asked whether the existence of tribes speaking separate dialects, and practising different customs, does not indicate a high antiquity. Australasia itself supplies an answer to this question in the differentiation of the Maori tribes and languages during the six centuries of their occupation of New Zealand. The study of African anthropology gives fuller and more striking evidence, as records show how greatly the East Coast tribes have changed since the sixteenth century, and, according to Sir Harry Johnston, all the numerous and very different tribes and languages of the Bantu, who occupy practically the whole of Africa south of a line from the Cameroons to the mouth of the Juba, have been developed within the last 2000 years. Dr. Flinders Petrie has also recently taught us that 1000 years appears to be the usual time required by a race for physical adaptation to its environment.

The references to authorities are irregular. The original intention was to include only the chief bibliographies, books containing summaries of results or lists of literature, and a record of books and papers published in the decade 1895-1904. But I was unable to complete the recent list, and I have gradually added some later and earlier references to those chapters where references may be most useful. The literature of Australian

geography is now so large that it was obviously impossible in a work of this size to attempt full reference to authorities. The most important of the recent literature is that published officially by the different States and the Commonwealth, which is but imperfectly represented in British libraries. As recent examples of this official literature, reference may be made to M'Alpine's *The Rusts of Australia,* issued by the Department of Agriculture in Victoria; the reports on the Pilbarra Goldfield, by Gibb Maitland in the Bulletins of the Geological Survey of Western Australia; and the valuable additions to the geography of the Northern Territory in H. Y. L. Brown's report issued by the Government of South Australia. Among recent books by private Australasian publishers, reference may be made to *The Plants of New Zealand,* by Laing and Blackwell.

A few of the illustrations from the earlier edition have been retained; for most of the new ones, I am indebted to Mr. A. E. Kitson, Mr. H. J. Grayson, Mr. W. H. Ferguson, and the Agents-General for New Zealand and Victoria. I am indebted to Messrs. W. R. Anderson, J. S. King, and W. H. Twelvetrees for the summaries of the mining laws of Victoria, Westralia, and Tasmania. For official literature I am indebted to the generosity of all the Governments of all the States and of New Zealand.

J. W. G.

GLASGOW, *November* 1906.

CONTENTS

CHAPTER I

CHAPTER II

CHAPTER III

CHAPTER IV

THE GEOGRAPHICAL STRUCTURE AND RESOURCES OF AUSTRALIA—

CHAPTER V

THE AUSTRALIAN FAUNA AND FLORA—

CHAPTER VI

THE GEOGRAPHICAL RELATIONS OF THE AUSTRALIAN FAUNA AND FLORA—

CHAPTER VII

CHAPTER VIII

CHAPTER IX

CHAPTER X

CHAPTER XI

CHAPTER XII

CHAPTER XIII

CHAPTER XIV

TASMANIA—

CHAPTER XV

SOUTH AUSTRALIA—

CHAPTER XVI

WESTRALIA—

CHAPTER XVII

NEW ZEALAND—

LIST OF MAPS AND DIAGRAMS

LIST OF ILLUSTRATIONS

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A

AUSTRALASIA

CHAPTER I

AUSTRALIA AND THE AUSTRALIANS

THE term Australasia has been variously defined. It means Southern Asia, so that it applies to the lands that lie to the south-east of Asia; but it does not itself define how many of those islands should be included within it. The name of Australasia may be conveniently restricted to Australia, Tasmania, and New Zealand with their subsidiary islands, excluding New Guinea and the Malayan Archipelago. This arrangement leaves all the Australasian lands in a group, whose most marked geographical feature is its long isolation from the rest of the world. Australasia, as thus defined, is the most completely isolated of the great lands of the world, except Antarctica; and Australia, in spite of its proximity to the islands of Malaysia and the persistent rumours of its existence, was the last continent to be visited and colonised by white men.

The geological history of the country shows that this isolation dates from a remote past, with the exception of a short connection between Queensland and New Guinea, which was not sufficient seriously to affect the conditions of Australia as a whole.

1. The Isolation of Australia

To the isolation of Australia from the other continents we owe the survival of the three-eyed lizards and the wingless birds of New Zealand, and the predominance in Australia of marsupials, a group which elsewhere either became extinct long ago, as in Europe, or survives in some inconspicuous, unimportant representatives, as in America.

Australian scenery is rich in suggestions of this long, undisturbed isolation. The unique aspect of its vegetation is due to development in a biological backwater. The sensational theory has been advocated that Australia was once occupied by European trees, such as the oak, the chestnut, and the elm. They were supposed to have lived in Australia at that remote time when the present mouth of the Thames was the estuary of a great southern river, which flowed through forests of palms, whose fossilised nuts still litter the Sheppey shores. But this view has not been confirmed. There is no reliable evidence that the European trees ever grew in Australia, and have been exterminated by the present flora. The vegetation of the period that immediately preceded the present was already isolated from that of Europe and Asia, and was the forerunner of the quaint Australian flora of to-day. The aspect of the Australian vegetation is unmistakably characteristic; though a few Australian trees have acquired the same forms as members of very different European genera. Thus the myall, an acacia (*A. pendula*), has adopted the habit of the weeping willow; the she-oak (*Casuarina*) often grows like the Italian stone-pine; and some acacias grow in flat-spreading branches like the cedar. But such cases are exceptional. The commonest trees, such as the gums with their mop-

head-like clusters of leaves, the gnarled needle-bush, the feathery she-oaks, the native honeysuckles decorated with their "bottle-brushes," and the quaint grass-trees have all distinctive forms; and the characteristic features of the trees, the dull lustre of the foliage due to the thickness and opacity of the leaves, the luxuriant tree-ferns in the wet forest gullies, the brightly tinted heaths in the glades and moorlands, and the blaze of mustard-yellow on the river banks and hill-sides when the wattles are in bloom, give Australian vegetation an aspect that is quite its own. The rapid growth of introduced trees, such as the Californian pine and European fruit-trees, shows that the characters of the Australian flora are not due to the climate, but to the isolation which protected it, and kept Australia apart from the main stream of plant development.

Geographically, there is equally striking evidence of the isolation. The topographical features of Australia are rich in remnants of land forms which date from primeval antiquity. For instance, Western Australia consists, in the main, of a vast block of old rocks, which, though washed at times on all sides by the sea, appears never to have been below sea-level during the time included in geological records; and some of the peculiarities of Westralian ore deposits appear to be due to the vast antiquity of the land surface beneath which they occur. The high bank to the west of Bacchus Marsh, 1000 feet in height, up which the train climbs on the way from Melbourne to Ballarat, is one of the oldest, well-preserved valley walls in the world. It was carved out by river erosion in Silurian times. It was in existence before the materials of which most of the Alps are built had been laid down in the seas of central Europe. It was old before the first bird or mammal or reptile had been born upon the

earth, and it dates back earlier than the building of the lands whose foundering formed the Atlantic Ocean. That old valley wall at Bacchus Marsh remained long hidden beneath sheets of sand, gravel, and clay, the partial removal of which has once more rendered it an important feature in the Australian landscape. It has again been protected by a cascade of molten lava that poured over its edge from the volcanoes of the plateau behind it; and that coat of rock has given a renewed lease of existence to this venerable geographical feature.

The physical isolation of Australia is paralleled by the social and political isolation of the early settlers—an isolation that protected the young colonies, and has rendered its population remarkably homogeneous. All classes of the Australian people live essentially on the same foods, have much the same interests, and the same general standards of life. The rich merchant may have a marble bath, and his servants will be content with one of enamelled iron, but they must have the bath, which is the essential. There is the same common interest in sports; the wealthy squatter has his pedigree racer and his professional jockey, while his stable-boy has a £5 pony, which he enters and rides himself. Newspapers are read with equal interest by all sections of the community; no one is so poor as not to afford his daily paper, while the weekly illustrated papers find their way to huts far below the grade at which one would expect to find them at home; and the weekly mail often brings an English paper as well, the squatter getting his *Spectator* and the boundary rider his *Lloyd's News*.

This remarkable unity of life, of interests, and of manners is a great source of strength to Australia, and

a security for its future welfare; for the stronger, abler sections of society are not handicapped by such a burden of the weak, the ignorant, and the discontented as in the caste-ridden countries of Europe. The character of the Australasian people is the most gratifying feature in the political development of this quarter of the globe. The national type is high, and shows that the early settlers must have been men and women of high character and sound morale. In spite of some adverse influences, the average Australian seems to me a distinct improvement upon the stock from which he has sprung.

The injury wrought to Australia by the convict importation is usually greatly overrated. The system of transportation was in use at the time when most serious crimes, from forgery to even sheep-stealing, were punishable by death. Most of the convicts sent to Australia were guilty only of minor offences; many were poachers, whose pluck and enterprise made them excellent colonists.[1] The total number of convicts was small in comparison to the free settlers. Transportation ceased long before the great influx of population, and some of the states never had convict settlements at all. Moreover, the hopelessly depraved and hardened of the criminals, those of whom we read in sensational novels, were in prison for life, and had little chance of leaving descendants. A more serious danger to the Australian population has been the drift of failures and "wasters," shipped out to the Antipodes by shamed British relatives. But even these unpromising immigrants are absorbed without much permanent injury to the race. The worst of them loaf about the coast towns; but most of them drift up country, where they learn to drink tea instead of beer, to do active work in the open air, and under

[1] Cf. quotation from Tenison Woods on p. 48.

healthier conditions of life they turn into useful, respectable men.[1]

Visitors to Australia are often struck by its exceptionally high standard of honesty, which is, perhaps, one of the natural results of the homogeneity of the population. The general honesty is one of the factors in the high efficiency of Australian work. The Australian workman insists on good conditions of work; his factory and mine must be well ventilated, and have all reasonable precautions for safety. He likes short hours; an eight-hours' shift is enough for him, as that leaves him time for rest and recreation. He eats good food, and has at least two meat meals a day. But during his work time he is working, and it is a pleasure to see him at it. Of course there are loafers, but, in the case of the gold mines, the industry of which I saw most, the other miners make it too uncomfortable for any one who tries to shirk his work. Hence the cost of supervision is reduced to a minimum. The proportion of men engaged in productive labour is at its maximum. And because of his eight-hours' shift, his good wages and food, and the goodwill

[1] The low proportion of crime in Australia has been recently illustrated by some statistics published by Mr. Coghlan in a letter to *The Times*, May 14, 1906. He shows that the passing of the Education Act in Victoria, in 1873, resulted in a remarkable decrease of crime. In the States of New South Wales and Victoria, the number of arrests, per 10,000 of the population, fell from 382 in 1880 to 242 in 1904. The number of criminal trials by the Superior Courts fell between 1875 and 1904 to exactly half—from 16 to 8 per 10,000. The actual decrease in crime is all the more remarkable when it is remembered how many European failures are shipped to Australia, and there commit an unfair proportion of the legal offences; thus in 1881 the arrests of adults born outside Australia were 142 compared with 100 amongst Australian born; in 1891 the proportion of arrests of immigrants was 145, and in 1901, 175 to 100 of native born. As Mr. Coghlan says, "These figures speak eloquently of the law-abiding character of the Australian-born population."

that comes of his comfortable conditions, Australian labour is so efficient, that it is cheap. The high-priced labour of Australia has achieved such economic triumphs as paying dividends out of a deep quartz mine which produces only $1\frac{1}{2}$ dwts. of gold to the ton,[1] as building broad-gauge railways across previously unsurveyed country at the rate of £1420[2] per mile; and it holds the record of cheap and rapid deep-shaft sinking.

2. Australian Politics and Defence

The isolation of Australia, however, has now ceased. Its kangaroos have been killed off and supplanted by sheep over large parts of the continent; in places beyond the bounds of European settlement, the indigenous fauna has perished, owing to the eating of its food-supply by the exotic rabbit. The dingo, which doubtless exterminated the Tasmanian wolf from the mainland, has in its turn been replaced by the sheep-dog. European weeds from seeds accidentally imported in hay used in packing, and sweetbriars and thistles introduced from careless sentiment, have taken possession of many square miles of good land. The fox, introduced for sport and to kill rabbits, has decimated the lyre-birds of Gippsland, just as the weasel is destroying the wingless birds of New Zealand. Starlings, bred from a couple of pairs let loose a few years ago, and the Indian minah, are now among the commonest birds around Melbourne, and a plague of

[1] *South African Mines* (Johannesburg, 9th September 1905, vol. iii. p. 624) refers to the regular dividends paid by the Central Ellesmere and Stewart's United, two Bendigo mines, from quartz yielding 2 dwts. per ton. It says that the working costs for mining and milling of 5s. 3d. and 4s. $0\frac{1}{2}$d. respectively "should cause envy in South Africa."

[2] The cost of the 26·45 miles, on gauge of 5′ 3″, from Birchip to Woomelang in north-western Victoria.

sparrows has spread throughout the cultivated areas of south-eastern Australia.

The European occupation has already effected a biological revolution in Australia, and the breaking down of the isolation by quick steam ocean transport is now producing a profound economic change. The cheap transport of frozen meat is equalising the prices of meat in England and Australia, by raising it as much in Australia as it has lowered it in Europe. Sheep, in times of drought, are no longer only worth the 4s. 6d. worth of tallow that could be boiled out of them. But this immense increase in the value of Australian produce involves a local rise in the cost of living. An old prospector once complained to me of the "prohibitive price of meat," as, with uplifted hands, he assured me that he had now to pay fourpence a pound for beef or mutton. Federation and Protection are often charged with the increase of local prices in Australia, where the increase is really due to the widening of its markets by the aids which science gives to industry.

The ever-lessening isolation of Australia by steamships and the cable is bound to revolutionise its economic and industrial life. The original policy of Australia was inevitably one of free trade, when it had a small population and vast areas of virgin land within easy access of the sea. It could then cheaply produce the raw materials, the wool and corn wanted in Europe, and exchange them for the tools, machinery, and capital required in the development of the land. But with a larger labour supply, and less virgin land near the coast, and the enormous markets of south-eastern Asia more open to trade, economic success depends on raising those high-priced products, which yield a higher margin for profit and wages. Australia is naturally considering how to use its vast

stores of coal in the smelting and manufacture of its vast masses of iron ores; and the woollen mills of Geelong and Ballarat are endeavouring to avoid the waste of carrying wool used in Australasia over 22,000 miles of sea. The local manufacture of arms, explosives, and iron goods is necessary as a simple matter of national defence.

The old political controversy of Free Trade *v.* Protection is, however, fast losing its interest in face of the new issues between the Labour party and those who doubt the practicability of its ideals.

The lessening isolation of Australia is also affecting the external politics of Australia. The shifting of the centre of foreign politics from the Near East to the Far East, and the growing importance of the problems of the Pacific, are forcing Australia to face questions of defence and foreign politics which were formerly less urgent. The early recognition of these coming changes and the partition of New Guinea have already had a profound influence, by hastening the federation of Australia. Recognition of the greater influence that would be paid to a single voice, speaking on behalf of united Australia, was, no doubt, one of the main motives of that movement.

The defence policy of the country is, of course, still dominated by the distance of Australasia from the countries with which it might come into conflict. Australia thoroughly appreciates the lessons of the South African war, as to the practical impossibility of any serious invasion; and the arguments used by Mr. Balfour in his well-known speech in the House of Commons on British military policy, to show that England is safe from invasion, apply still more strongly to Australia. Nor has she much to fear from raids. Her coast towns are not laid out along the ocean beach. All the capitals and chief ports are either some miles inland, or situated

far from the open ocean, up estuaries or harbours, which afford excellent facilities for defence. Thus—

Sydney is 4 miles from the ocean, up Port Jackson harbour.

Melbourne is $2\frac{1}{2}$ miles from the shore of Hobson's Bay and 40 miles from the ocean.

Adelaide is 6 miles from the shore of St. Vincent's Gulf.

Brisbane is 12 miles in a straight line, and 25 miles by water from the shore of Moreton Bay.

Perth is 12 miles inland from its port at Fremantle.

Hobart is about 12 miles from the mouth of the Derwent.

In New Zealand also most of the towns are far from the open sea.

English critics of Australia often write as if the destruction of Melbourne or Sydney by a hostile battleship would be an easy task. But a battleship that intended to bombard Melbourne would have to run up a long, narrow, sinuous channel, a mile in width, guarded by forts, well-armed with powerful, modern guns.[1] After having run the gauntlet there, it would have to continue for 40 miles across Port Phillip, through a somewhat irregular passage, which offers exceptional opportunities for defence by mines; and I have been assured by a competent authority that the plan of mining defence is adequate and well designed. Meanwhile the hostile ship would be liable to attack from the excellent flotilla of torpedo boats,[2] backed by a well-armed coast-defence vessel. If

[1] "Upwards of £900,000 have been spent on fortifications and their armaments by the Colony of Victoria. Port Phillip, like Port Jackson, has been made one of the most strongly defended ports of the Empire." Hon. T. A. Brassey, "Studies in Australia in 1896." *Proc. R. Col. Instit.* vol. xxviii. p. 120, 1897.

[2] The Brennan torpedo, it may be remarked, is a Melbourne invention.

the battleship escaped these dangers, the amount of damage she could do to a scattered town like Melbourne would be comparatively small. Melbourne is spread over 254 square miles. The number of shots that can be fired from a modern big gun is a matter of lively controversy; the estimates vary from two or three dozen to two or three hundred; but when allowance is made for the rounds that must have been fired in practice, and the rounds that a battleship would require to keep in reserve for her own defence, the number of shots she could afford to fire at Melbourne would be comparatively small. Every shot she fired she would have drawn one of her own teeth. A battleship could not land any men. So if Melbourne declined to be bluffed and remembered that the battleship could do less damage than a hurricane, and that its visit would be much less costly than a drought, the raider could do nothing to justify his risks.

The defence policy generally advocated in Australia is, firstly, the defence of the ports by efficient torpedo flotillas, backed by strongly armoured, well-gunned coast-defence vessels, with powerful forts at the entrances to the harbours, and well-designed fields of mines. Secondly, universal manhood training for defence on shore. It is maintained that every man should be able to ride and shoot. This training is begun in cadet corps at the schools, and is continued by rifle clubs. This national defence policy has made very different progress in the different states. The cadet corps training has been best developed in Victoria and New Zealand. "Military drill," says the latest Regulations for the State schools of New Zealand (1904, p. 7), "must be taken by boys in every school in which there are twenty or more boys of twelve years of age or upwards, as provided in the regulations for public school cadet corps." In Queens-

land every man is liable to be called out for the defence of the country. This policy, according to some Australian politicians, has been greatly delayed by some of the military authorities, who have hitherto been appointed from home, had no sympathy with it, and are said to have hindered rather than helped it. Whether this suspicion be just or not, Australia has now entrusted the organisation of her forces to an Australian committee, and appears to have resolved not in future to appoint Imperial officers to the chief command of her forces.

Naval defence is at present of secondary interest to Australia, though it is becoming of increasing importance with the rapid growth of the Australian mercantile marine. The security of Australia is sometimes represented as due solely to the British fleet, and Australians are warned that if that protection were withdrawn, Australia would be promptly annexed by some foreign power. This view is as extreme as that of those Australians who say that the destruction of the British navy would make no difference whatever to the security of Australia. They point out that the main function of the British navy is the protection of the British food-supply. Australia, being self-contained, could not be starved into surrender, and her vast size renders her safe from vital injury by any hostile fleet.

Australia is far more concerned with the land than with the sea, and the growth of Australian interest in naval matters has probably been delayed by the recent Naval Agreement. Victoria, for £30,000 a year, used to maintain a naval defence force, which appears to have been remarkably efficient and was amazingly economical. But now Australia contributes £200,000 a year to the British navy, and in return relies on the protection of a British squadron. Many Australian Imperialists deeply

deplore this arrangement. They point out that the money is practically nothing as a grant in aid of our navy, with its expenditure of £34,000,000 a year. They say that if Australia were encouraged to establish its own navy, its subsidy could be spent far more efficiently locally than by the Admiralty from London, and that the possession of a small navy would inevitably stimulate Australian interest in naval matters, and lead to the ready voting of whatever increased expenditure might be necessary. England may be certain that any Australian fleet would be at her disposal in the Pacific or Indian Oceans as promptly as Australia dispatched a gunboat to China in 1900, and offered her troops for service in South Africa in 1899.

But to satisfy a formula as to the sea being one and indivisible, England wounded the feelings of the Australian and New Zealand people by refusing to trust them to volunteer in the future as they have done in the past; she preferred to take a dole as a naval contribution, which under the circumstances was somewhat grudgingly granted, instead of enlisting the active co-operation of the Australasians in naval affairs.

The much-abused "White Australian" policy, as shown by the recent controversy over the Mail Contracts, is an essential part of the Australian defence policy. Australians point to the steady decline in the number of British seamen, and the increase of aliens on British ships. Australia is determined to develop a well-trained body of her own seamen, who shall be available for the defence of her coasts. Accordingly, she insists that all her own vessels shall be manned by crews of well-paid white seamen. And it would be obviously quite unfair to her own shipping trade and fisheries to leave them to compete with foreign vessels, manned by low-priced

coloured labour. So Australia declined to subsidise vessels manned by black crews, and is placing vessels taking part in the Australian coasting trade and fisheries under the same restrictions as to work and wages, while in Australian waters, as her own vessels.

Australia was severely criticised in the British press for her thoughtlessness in insisting that Australian mail steamers should have white crews; it was pointed out there are not sufficient British seamen available, and that this action would give a preference to alien Germans over British Hindus. That is Australia's justification. It is doing its best to avoid the danger of an inadequate reserve of seamen. Her own coasting trade is to be worked by British seamen, to secure industrial prosperity in peace, and safety in war.[1]

3. The "White Australia" Policy

In spite of the singular interest of the past of Australia, the interest of the continent is now essentially in the future. Its unique opportunity is due to the fact that it is the one continent of vast natural wealth, most of which has a healthy, temperate climate, which can be occupied by white men without any serious change in their habits of life, and which was found practically unoccupied. The original population was probably only about 150,000, or not more than one to every twenty square miles.[2] Except in the waterless

[1] Since this was written the Chairman of the Orient Company stated at the Annual Meeting of the Company, that there is no substantial difference in cost between white and black stokers. And the Imperial post-office has accepted for the West Indian mails the poundage system, which the Australian Government proposed to adopt.

[2] The official estimate of the number existing in Victoria in 1836, at the settlement of that colony, was 6000: reference to other estimates are given in *Proc. R. Soc. Vict.* vol. xvii. new ser. 1904, pp. 142-143.

wastes of the interior, and the narrow belt of low coast lands on the north, all the work necessary to develop the continent could, in the absence of the black or yellow races, be done by white labour. Australia offers a great opportunity for the development of a prosperous industrial community; for it is a rich field only partly occupied; it is sheltered by its distance, but easily accessible to trade; while it is unhampered by hereditary interests and servile traditions.

Australia offers a chance of developing a great white man's continent, with the most homogeneous white population in the world, if it considers such a result worth the sacrifice necessary to preserve the purity of the race. The white Australia policy may necessitate a slow growth, though it would probably be a strong growth.

The white Australian question is at the present time the most important problem in the political geography of the continent. It depends ultimately upon whether Europeans can colonise the tropical countries of Northern Australia. If it should be impossible for these countries to be adequately developed by white labourers, then Asiatics or Kanakas must in all fairness be allowed to work them.

The countries of the world are popularly divided into white man's country, and into the tropical areas in which, it is thought, white men cannot undertake hard physical exertion with reasonable comfort and good health. It is generally held that there is something in the tropical climate which is inimical to the health of Europeans. Medical authorities on tropical climates seem now, however, to be coming to the opinion that this view is a popular prejudice which does not rest on an adequate foundation. Comparison of the death-rate of

England—19·2 per 1000—with the old estimate for West Africa—

> Oh! the Bight of Benin, the Bight of Benin,
> For one that comes out, there are forty go in—

would suggest that the tropics are less healthy than temperate climates. But it is not enough to compare an unusually healthy temperate country with an exceptionally unhealthy tropical one. The death-rate of Russia, 35·4 per 1000, compared with that of 18·7 in Curaçao, one of the Dutch West Indies, or of Jamaica, 22·2 per 1000, shows that some tropical localities are far healthier than some temperate ones.

The supposed unhealthiness of the tropics is attributed to the heat. But there is nothing in the heat of any climate in the world which is necessarily fatal to European races. It has been frequently pointed out that the tea-planters of Assam are exceptionally healthy, although their duties require them to be out in the hottest seasons, and in the hottest part of the day in a tropical country. Many classes of men, such as steamship stokers, working for four hours at a time, at a temperature of 150°, in the close and oily stoke-hole of a steamship, and glass-blowers, men at metallurgical works, and the women in the Paris bakeries, are exposed to temperatures far higher than those naturally met with in any part of the world. The attendants in Turkish baths have to work in greater heat and a moister air than that of any tropical country. Still fiercer heat can be tolerated in dry air; thus Sambon, in an interesting paper—"Remarks on the Possibility of the Acclimatisation of Europeans in Tropical Regions"[1]—quotes cases of men working in ovens of which the

[1] *Brit. Medical Journal*, January 9, 1897.

temperatures are 350° F., and of Chabert, the Fire King, who used to enter an oven the temperature of which was from 400° to 600° F.

The popular belief that European children cannot be successfully reared in tropical countries appears to be also out of date. The statistics of the big centres of population in the tropics compare unfavourably with those of Europe, because the tropical centres are mostly in places which are very insanitary. According to Sambon, infant mortality among European children in Calcutta is 58 per 1000; but this is far lower than the infant mortality of the native races in the same town, where with the Mohammedans it is 363 per 1000, and with the Hindus it is 315 per 1000. And the high Calcutta death-rate for English children is low in contrast with that of some English districts; thus at one Lancashire town the rate of infant mortality is 270 in the 1000. Sambon quotes Sir Joseph Fayrer to the effect that experience has proved that, under proper hygienic conditions and careful management, the European child, whether born in India or imported from England, may live and thrive "almost as well as in Europe."[1] Moreover, where

[1] A recent paper by Dr. J. S. C. Elkington, "Tropical Australia: is it suitable for a working White Race?" read before the Royal Society of Tasmania, November 1905, and reprinted, *Commonwealth of Australia Parl. Papers*, 1905, No. 59, endorses Sir Joseph Fayrer's view, going so far as to declare that "it is overwhelmingly a question of parental care." As knowledge increases this care can be more intelligently directed, and a great diminution of infant mortality is the result. It must be remembered that Anglo-Indian children are now sent home for education as much as for health. The mental atmosphere which produces the normal Englishman cannot be created in the midst of an enormous population differing from our own in race, religion, and moral and social ideas. The Anglo-Indian is as determined as the Australian that his son shall inherit the traditions of his race, and removes him from contact with an Oriental race, for much the same reasons that the Australian refuses to domicile an Oriental race around his home.

Europeans are resident in the tropics, the rate of mortality is lower amongst those who are engaged in active work out of doors, exposed to the sun, than it is amongst those who are cooped up in the towns. It has been pointed out that the European troops in India are healthiest when exposed in the field, and most sickly when resting in the shelter of their barracks.

The high death-rate that used to occur in the tropics has been very greatly reduced by care and sanitation. The mortality for the troops in active service in India for many years before 1859 is given by Sambon as 69 per 1000. A Royal Commission in 1864 expressed the hope that scientific sanitation might reduce the rate to 20 per 1000; but it has come down to 12 per 1000. Some of the West Indian Islands, which had an extremely bad reputation for their unhealthiness, *e.g.* Barbados, are now, according to the health statistics of their garrisons, healthier than military stations in the British Islands.

The human race was probably originally evolved in the tropics, and there seems no reason why the residence of the white races in the temperate regions should have so altered them constitutionally, that they cannot again live and work, under favourable conditions, in their original home. There is much to be said for Sambon's view that acclimatisation is a mere question of sanitation, and of protection against diseases such as malaria, yellow fever, etc. Sambon maintains—"First, that European emigrants can live and perpetuate their kind in tropical regions; secondly, that the difficulties in the way of colonisation are not due to climate, but to parasitism; thirdly, that acclimatisation is, to a great extent, a mere question of hygiene."

It is often said that it is physically impossible for

white men to work in the Queensland sugar-fields; but this statement is contradicted by the facts, some sugar-cane plantations in Queensland being already worked by white labour. There seems no sufficient evidence that white men are constitutionally unfit for manual labour in such climates. The French once thought that they would never be able to colonise Algeria. Sambon quotes General Duvivier: "Que les cimetières sont les seules colonies toujours croissant en Algérie." But Algeria is now one of the best and most popular of the sanitoria for European invalids. A recent medical mission in West Africa has predicted that that once deadly coast will be made a holiday sanitorium, like Algeria and some of the West Indies.

The old high death-rate of the tropics was due, not to heat or to climate, but to the prevalence of parasites and germs, such as those of malaria, yellow fever, dysentery, beri-beri, elephantiasis, etc. When these parasites are discovered and their life-histories known, there is no more reason why these tropical diseases should not be easily cured, and even wholly destroyed, just as leprosy has been driven from England, as trichinosis has been eliminated by meat inspection, hydrophobia by control of dogs, malaria has been driven from Essex by drainage, and the scourge of small-pox removed by vaccination.

Current research on tropical diseases promises to remove climate as a factor limiting the occupation of the tropics by white races.

The question is, however, not one of health alone. White men can, no doubt, do manual work in the tropics; but they will not do the rougher forms of labour where there is a servile, black population available. We hear from the directors of the gold mines of the Rand that white men will not work side by side with Kaffirs.

This statement is probably true. But if there were no black races in Africa south of the Zambesi, white men would doubtless be ready to do all the work which has to be done there. Flood Australia with cheap Asiatic labour, and probably the white men would decline to do the simpler, heavier forms of work which they at present do quite willingly. There would be no room for the less efficient whites who have not enough brains to be trusted with the supervision of labour. They would sink to the condition of the "mean whites" of the Southern States of America, and become a source of danger to the community. Every nation ought to arrange to employ its own inefficients, and fight its own battles. No nation has yet become great which left aliens to do its manual labour, or has become powerful if it entrusted mercenaries with its defence.

The effect of climate on energy, as apart from health, has also to be considered. Life in a hot, moist climate does, no doubt, diminish a man's energy. A workman is physically more efficient in a temperate than in a tropical climate. But this decrease in working efficiency is counterbalanced by the decrease in needs which accompanies an increase in mean annual temperature. In the tropics, men can do with less food, fuel, and clothing; clothes may be of cheaper material and houses may be less expensively built. The conditions of life are easier. At the same time, the returns of labour are more generous. A man in the tropics would no doubt plough a shorter length of furrow, or shovel a smaller load of earth than the same man would do with an equal amount of exertion in a cold country. But the same amount of labour, put into a tropical soil, would produce a more valuable crop.

Whether it is to the economic advantage of Australia

to develop the tropical territories rapidly, by black labour, or slowly, by white, is a political question. Either course is possible. Australia must remember that the "White Australia" policy means that at present she cannot compete, in some industries, with tropical or sub-tropical lands possessing abundant cheap labour. Cotton-growing is perhaps one such industry. There is no doubt that northern Australia will grow valuable cotton. That fact was amply proved half a century ago. The reports of the Manchester Chamber of Commerce on samples of Australian-grown cotton, published by Lang in 1852,[1] are convincing, and they have been fully confirmed by later experiments. But a cotton crop wants an ample supply of cheap labour for the short picking season. It is just the sort of work that suits negroes and Egyptian fellaheen, who love short jobs, and on such work with a spurt, cheaply and well.

No doubt in time, when Australia has become more densely peopled, arrangements might be made whereby labourers could be engaged for a short spell on the cotton-fields, and for the rest of the year on some other work. But it looks at present as if a white Australia means a considerable delay in the establishment of an Australian cotton trade.

4. The Labour Party and its Ideals[2]

The remarkable interest of Australian politics is in its experiments. The conditions are sufficiently simple

[1] J. D. Lang, *Freedom and Independence for the Golden Lands of Australia*, 1852, pp. 284-288.

[2] Special reference is made to the Labour party simply because it is the party that is most often misunderstood. It is not to be inferred that the author regards it as the best or wisest political party in Australia, and he is conscious of the dangers to its future development.

for the effect of an experiment to be watched, and yet the field is large enough for the results to be practically instructive. The intensely democratic communities of Australia and New Zealand are always open to new ideas, and ready for fresh experiments.[1] The democratic principles of the country are a matter of habit and instinct; they are not adopted in a spirit of philanthropic benevolence, as they were in Britain by the Young England party, or as a matter of intellectual conviction, as among British Liberals. Democracy in Australia is not a distant ideal to be sought and fought for. The young Australian breathes it in, like the oxygen of the air.

No one can spend even a short time in Australia without realising that its future Government will be largely influenced by the Labour party. That party has had great power without much direct responsibility in the past; and it is clear that in the future it will have direct responsibility as well as power. The general British idea of the Australian Labour party is a phantom. This misconception is not surprising, for the most active members of the British Labour party have not been restrained by a sense of immediate responsibility. Their main efforts have been to arouse men from political apathy; exaggeration in their appeals was inevitable, and perhaps excusable. The general idea of the Australian Labour party expressed in the British press seems an image of the most reckless section of the English party, magnified according to its greater power. But the Labour parties of Australia and Great Britain are strikingly different. Mr. Tom Mann, who recently went out to Australia, in one of his fiery orations, appealed to

[1] The most recent is the drastic legislation passed in Victoria against secret trade commissions.

the men of Australia to throw off their chains; and he denounced existing authorities in the approved manner of the European revolutionist. He was promptly told by his own side that that sort of thing was "fluff." He was reminded that the Labour party had only recently held the Commonwealth Government, that it held a two-thirds majority in the Senate (the Upper House in the Commonwealth Legislature), that Labour Ministries were in office in Western Australia and Queensland, and that the Labour party was powerful, and might at any time take office in Victoria and New South Wales; and that, therefore, if the Australian workmen were "in chains," it must be because they liked them.

The Australian Labour party has not spent its energies in denunciation of authority. It has a practical, constructive policy, and has shown that its leaders have the ability to carry it out. New Zealand, under twelve years of Labour Government, has advanced to unprecedented prosperity; and the fact that Australian stocks increased in value in the European money markets while the Watson Labour Ministry was in power, shows that full confidence was placed in its honesty of purpose and method. The feature that surprised me most in Australian politics was the moderation of the immediate demands of the Labour leaders. As a Conservative in British politics, I went to Australia with the "bogey" idea of the Australian Labour party. I was very surprised to find less socialistic legislation in Australia than there is in Britain. It is true that in Australia the railways are owned by the States; the legislation limiting hours of work in factories and shops is more advanced than in Britain; some of the States have laws providing a minimum wage, they enforce compulsory arbitration, and give old age pensions. But on the other hand there

are no poor laws; there is nothing like the advanced municipal socialism of such cities as Glasgow; the trams are generally held by private companies; the laws for the protection of workmen in factories are far less stringent than at home; colliery and mine owners may employ any manager they choose, and the State does not test his efficiency; and the supervision of food (excepting meat), of sanitation (excepting quarantine), and of artisans' dwellings is all decades behind the industrial legislation of Great Britain. The Australian laws are only more advanced where the simpler conditions allow matters to be controlled by law, which in England are left to agreements between committees of employers and the powerfully organised trade unions.

The foresight of the Australian Labour party has been repeatedly shown by its attitude to legislation which involves some present sacrifice of the comfort of its supporters for the sake of their future welfare. The advanced temperance legislation in Australia was mainly carried by its insistence. The Labour party is generally regarded, at least in Victoria, as amongst the strongest supporters of a system of advanced national education; it has taken up a sound policy in regard to the spread of technical education; it shows sympathy with the higher educational institutions such as the universities, and warmly supports all means of public culture, such as free libraries and picture-galleries. It shows an intense distrust of militarism; but it appears to approve of universal manhood training in school cadet corps and rifle clubs, for national defence. The widespread belief that Labour is all anti-Imperialist is difficult to reconcile with the fact that the late Mr. Seddon, the Democratic Premier of New Zealand, was the most enthusiastic champion of Imperialism; and the Commonwealth

Parliament passed a resolution in favour of preferential tariff within the Empire, owing to the support of Mr. Watson, the Labour leader.

The fundamental principles of the Labour party do not seem to be essentially anti-capitalist. The aims of its policy are to secure reasonable equality of chances by providing free education and fair opportunities; to develop a healthy, vigorous race by securing sanitary homes and conditions of work; to spread a spirit of national patriotism and goodwill by preventing the growth of hostile social classes, and to give every man the opportunity for culture and recreation. The members of the Labour party point to the extreme differences between classes in Europe, and the deplorable consequences of such inequalities. They point out that the unrestrained individualism of America is leading to the same results there, and tends to inculcate a spirit of selfishness. Australia, they say, is a country which can produce sufficient food and clothes for a large population, and sufficient metals and produce, which are wanted in Europe, to provide the capital for its development. Australia, they claim, should be so governed that it should provide work and fair wages to a vast industrial population; that it should be able to afford a fair day's wage for good workers; and that its work should be performed under such comfortable, healthy conditions, that the workers may take an interest in their work, and have sufficient time for culture and recreation. It is better, they claim, that Australia should have a large, well-educated, contented, working population, than that it should produce a larger yield of wool and cotton by a servile, black population.

The Australian policy of excluding undesirable alien immigrants aims at maintaining the high standard of the race. It has been much misunderstood in England.

Australia knows how important a greater population is to her, and has shown no intention of excluding white men. The danger to Australia of allowing free Asiatic immigration is serious; as the northern coast is only four days' voyage from the overcrowded countries of south-eastern Asia, with their teeming populations of Chinese. No such danger has threatened England, and yet there is an Act for the exclusion of undesirable aliens. The Asiatics have always been near Australia. No doubt they have known of its existence for many centuries. But they made no attempt themselves to occupy the continent. It is only when British enterprise has opened the continent, has given it good roads and railways, and wells, and has made it safe for the traveller and the trader, that the Hindu pedlar would like to go in and reap the benefit.

There is plenty of room for the Asiatic in his own continent, and there is ample work for him in its development. Sir J. A. Baines has pointed out in his paper on "A Census of our Empire," that the peopled parts of Australia—and the Asiatic will only go to them—have comparatively dense populations. The average is only low when we include the vast regions which are still unoccupied. Thus he divides the population of the Australian States into the densely peopled and sparsely peopled districts, of which the populations are as follows:[1]—

[1] *Journ. R. Stat. Soc.* vol. lxvi. 1903, p. 12.

	Densely Peopled.			Sparsely Peopled.		
	Percentage on Total.		Density.	Percentage on Total.		Density.
	Area.	Population.		Area.	Population.	
Victoria . .	20·43	73·51	48·94	34·16	3·51	1·39
South Australia	1·34	79·71	23·79	2·51	1·67	0·27
Queensland .	1·49	44·26	22·28	53·94	4·85	0·07
New Zealand . .	31·60	46·31	10·92	68·40	53·69	5·85

When we turn to some of the Russian districts of Asia there are regions, such as the Amur Region, with an area of 172,848 square miles and a population of only ·9 per square mile; Yakutsk has only ·2 per square mile, to an area of 1,533,397 square miles; and the district of Primorskaya, with an area of 715,982 square miles, has a population of ·3 per square mile.[1]

The Alien Immigration Acts of Australia are less exclusive than those of the United States and Canada, and are only directed against coloured races. It is true that an educational test is employed; but this test was selected at the suggestion of the British Government. No alien is admitted unless he can write down a short sentence in any European language the Customs Officer may select. Only half a European,[2] as I understand, so far, has been excluded under this Act; this man was called on to write a sentence in Greek; he was apparently a very undesirable person, and was excluded. This test might be used to keep out an Englishman; and it is sometimes suggested that any one who can write an English sentence should be admitted. But this arrangement would open the door to any Asiatic, for all the Hindus and Chinese who want to enter have probably learnt some English, or would soon do so.

[1] J. S. Keltie, *Statesman's Year-Book*, 1904, p. 1032.

[2] A German-Arab half caste.

The law refusing to allow the entrance of manual labourers under contract has also been represented as due to an Australian desire to exclude British labourers. But it has never been used for this purpose, and probably never will be so used. The object of this law is to prevent the enlistment of cheap European labour at rates of wages which, though they might sound very attractive to an Italian peasant, would be quite inadequate in an Australian up-country mining town. Hence Australia refuses to allow the entrance of unskilled artisans under contract: for they may have made such contracts in utter ignorance of Australian conditions. The men may come in as free labourers, and then, when in Australia, they can agree to any legal contract that they like.

The aim of the white Australian policy is to produce a race that shall be equal to its opportunity, and to the best of British traditions. Its advocates believe that the British race is better than that of the Chinese or the Hindu, and that it would be lowered and not improved by intermixture of Asiatic blood. They believe in the dignity of labour, and the benefits of the simple life; and they do not hold these doctrines as mere cant. They believe that a race must do all its own work, and that no honest, necessary work is degrading. They do not believe in the equality of men of the same race; and so they point out that, if a nation employs blacks to do its manual labour, there is no respectable livelihood left for the less efficient of its own people. The policy of the democratic party in Australia is, therefore, to develop a people that shall be equal to its chances, preserve the purity of the race, and so build up a happier community, and a civilisation that is an improvement on that from which it has sprung.

5. The Hopefulness of Australia

How far the interesting democratic ideal of Australia is practicable, time alone can show. There are many difficulties in the way. The democratic party is large, but it is not united on questions which seem essential to the success of its policy. The different states have different interests. But if the ideal of the Liberal party cannot be reached in Australia, it is hopeless elsewhere. The most striking feature, both of Australia and of Australian life, has always seemed to me to be its hopefulness. The open plains inspire an exhilarating sense of freedom; the bright sunlight in the clear, dry air is a cheering tonic in contrast to the anæmic dulness of our sunless towns. The Australian weather is by no means all sunshine. The weather is boisterous; the winds sweep across the plains with no break upon their speed, and the rains are cold and very wetting. The climate is in many ways hard, and in some ways dull. There are spells of cloudy skies, and, owing probably to the absence of green from the ground, the grey of the Australian clouds is a black and white grey of an unusually dreary tone. But when the clouds break, the sunlight pours through, and in the sunshine the Australian bush looks its cheeriest and its best. Nature is often very hard in her dealings with man in Australia. Droughts are disastrous; and with annoying immoderation, they alternate with devastating floods. But the Australians take things as they come. As soon as he has recovered from one visitation, with indomitable pluck he begins afresh, and quietly sets himself to restrain future excesses of nature. He starts great irrigation schemes, sometimes with reckless disregard of cost, and he builds vast storage reservoirs to guard against a recurrence of drought; he keeps his

rivers in order with long training walls, and to lessen floods he patiently snags a few thousand miles of Murray; he will pump water 350 miles through an iron pipe, carrying it over a mountain wall, 1800 feet in height, to supply a thirsty mining-field. Australian engineering works are often audacious, and they are generally successful. When the Coolgardie water-pipe was under discussion, figures were published to show that the water could not be forced through it. I was told by a Westralian politician, who opposed the scheme as he believed it to be impracticable, that he once showed Sir J. Forrest some calculations to prove that the water could not travel through his pipe. Sir J. Forrest emphatically replied, that if it could not be managed any other way, he would sit on one end of the pipe, and himself force the water through. And when a party of resolute Australians sit on a scheme, they generally get it through. They are aided by the marvellous recuperative powers of Australia; for, if temporarily discouraged, they are inspired to fresh exertions by its encouraging cheeriness.

The dominant aspect of Australian scenery has often been described as a "weird expectancy." But it has enough beauty for deep enjoyment, without expectation of anything more; and its prevailing aspect seems to me hopefulness rather than weirdness. Australian scenery undergoes sudden transformations, which sweep away the memory of a spell of discouragement and discomfort in assured confidence for the future. I remember one such, after a forty miles' journey, much of it over an open beach, across which a fierce wind drove pelting sheets of rain and spindrift. The errand had proved fruitless; so I was riding back wet and weary, and a little disappointed at the waste of time. Suddenly the sun

crossed a narrow bar of open sky on the horizon, and flashed a shaft of light between the low-hung clouds and the heaving sand-dunes; the fresh grass became translucent; the trunks of the white gums glistened as if they were incandescent; the masses of foliage flushed pink as the young leaves reflected the low sunlight; and the white crests of the sandhills glowed with a rose-red light. There was nothing weird in that scene and no expectancy of anything further was necessary for enjoyment of its beauty. The exquisite colour effects lasted but a few minutes. As we started again upon our way a kangaroo sprang from the bushes, and as we galloped after it along the track, its graceful movements and its long, easy leaps seemed beautifully appropriate to that wide, free land. Warmed by the race, and thrilled by the sunset, I forgot that I was wet, and ceased to be cold and weary, and rode on through the fast deepening gloom thrilled once more by the fascination of the Australian bush. No wonder Australians love it, and have learnt a keener, and, I think, a truer appreciation of Nature than is usual at home. They have not yet given popular names to many of their familiar flowers; their enjoyment of them is quite independent of names, traditions, or folklore. They love the flowers for their beauty and perfume. They do not make daisy chains to dance with; but they go out in special "flower trains" from Albany, to enjoy the sight of the Westralian moorlands ablaze with a carpet of spring flowers; while picnics, to "welcome the wattle," when the river banks and the hill-sides are aglow with its bright yellow, are among the most popular of annual excursions to the people of the towns.

Kipling truly expresses the love of the Australian for his bush, when he makes his New South Wales

trooper stirred to the depths by the scent of his native wattle—

> Smells are surer than sounds or sights
> To make your heart-strings crack—
> They start those awful voices o' nights
> That whisper, "Old man, come back."
> That must be why the big things pass
>   And the little things remain,
> Like the smell of the wattle by Lichtenberg,
>   Riding in, in the rain.
>
> It was all Australia to me—
> All I had found or missed:
>
> . . . .
>
> That smell of the wattle round Lichtenberg,
>   Riding in, in the rain!

No one can have travelled much in Australia and learnt to know its people without feeling full confidence that, after its past eras of isolation, and in spite of periodic drought, and its adventurous democracy, it is now "riding in" to a career which will be worthy of the glorious traditions of the British race.

CHAPTER II

THE DISCOVERY OF AUSTRALIA

THE political discovery of Australia dates from the work of Captain Cook in 1776. But the existence of Australia had been known, or had at least been believed, from prehistoric times. The classical geographers, after their demonstration of the spherical form of the earth, regarded the existence of a great southern continent as necessary to its equilibrium. They knew of a great extent of land in the northern hemisphere, and of great seas to the south; so they thought that there must be some great continent in the southern seas to counterbalance the weight of the northern lands. Hence, in opposition to the Œcumene—the known land of the world—they established an unknown continent, the Antichthone in the south. This southern land was regarded by some of the classical geographers as possibly inaccessible from the north; for the land of the torrid zone might be impassable owing to the heat, and the sea owing to the thickness of the water, due to its concentration by evaporation. The southern land was, nevertheless, believed by some to be inhabited.

Such views lasted until the time of the great mediæval explorers. Columbus was a firm believer in the necessary existence of the southern land, and maintained that it

must be inhabited, as otherwise the decree would not have been given to preach the Gospel in all corners of the earth. When such beliefs, founded only on speculation, gave place to actual knowledge is doubtful. The early Arab sailors, who made such bold voyages across the Indian Ocean, might have reached the Australian coast from the Spice Islands of the East Indies; and that they did so is suggested by their stories of great pouched animals, which appear to indicate some knowledge of the kangaroo. It is most improbable that the daring Malays who, in prehistoric times, sailed as far westward as Madagascar, should not have crossed the narrow sea that separated the islands of Malaysia and Australia. It is accordingly not surprising that travellers to China and Malaysia during the fifteenth and sixteenth centuries should have brought back tidings of a great southern land. These rumours are recorded in the statements and maps of the mediæval geographers. Thus the British Museum map of the world which dates from between 1487 and 1489, and is thought to be a copy of one made in London by Bartholomew Columbus for Henry VI., represents a land running far southward from Malaysia on one side of the Indian ocean, opposite to Africa on the other. This land may be only an exaggerated representation of the Malay peninsula; but it may also indicate an imperfect knowledge of the western coast of Australia. Martin Behaim's famous globe of 1492 shows many islands to the east of the Indian Ocean; and they also may be founded either on knowledge of Australia, or be an exaggeration of the extent of the Malay archipelago. The Hunt-Lennox globe, which is considered to date from between 1506 and 1511, shows a great land to the south and south-west of Malaysia, which certainly looks as if it might be Australia mis-

placed to the west. Ludovici Barthema of Bologna, who claimed to have travelled through the Spice Islands from 1503 to 1508, tells us how he sailed to Java, where the Captain said that, farther to the south, he was no longer able to see the north star, so he steered by four or five stars. "He also told us that, on the other side of the said island, towards the south, there are some other races who navigate by the said four or five stars opposite to ours; and moreover they gave us to understand that beyond the said island the day does not last more than four hours, and that there it was colder than in any other part of the world. Hearing this we were much pleased and satisfied." Barthema's statement probably shows that the Malay seamen knew how to discover the position of the south celestial pole from the Southern Cross. That the Malays had gone into southern latitudes, where the day is only four hours long, and where it is colder than in northern China, may be disbelieved, without it following that they had never reached the continent of Australia. The existence of a great land to the south-east of the Spice Islands was again asserted by Corsali, in 1515: "And navigating towards the east, they say there lies the land of Piccinacoli [New Guinea], and many believe that the land is connected towards the east in the south with the coast of Bresil or Verzino [Brazil-wood], because, on account of the size of this land of Verzino, it is not as yet on all sides discovered."

During the latter part of the sixteenth century many well-known maps show a great land in the position of Australia. Thus the Dauphin map, which is the copy of a plani-sphere of somewhat before 1530, shows a great land south of Java, and calls it Java-la-Grande; and Jean Rozes' chart of 1542 shows, to the south of Lytil Java, a "Land of Java," of which the outline has

many points of unquestionable resemblance to that of Australia. Mercator's map of 1567 gives a more sketchy outline of northern Australia. In 1597, there is the oft-quoted passage from Wytfliet, describing Terra Australis: "The Australis Terra is the most southern of all lands. It is separated from New Guinea by a narrow strait. Its shores are hitherto but little known, since, after one voyage and another, that route has been deserted, and seldom is the country visited, unless when sailors are driven there by storms. The Australis Terra begins at two or three degrees from the Equator, and is maintained by some to be of so great an extent that, if it were thoroughly explored, it would be regarded as a fifth part of the world."

The evidence, therefore, renders it probable that European geographers of the sixteenth century had some rumoured knowledge of the existence of Australia. Early in that century the southern islands of Malaysia were known with some accuracy. Thus the portalano of Rodriguez, the pilot in d'Abreu's expedition of 1511, gives a fair representation of Sumatra, Java, Bali, Lambok, and the Moluccas. New Guinea was visited as early as 1526 or 1528. It certainly appears excessive caution to regard the land shown to the south of Malaysia as founded on exaggeration of those islands. It seems more probable that the daring Malay sailors should have discovered the northern coasts of Australia, than that European cartographers should have blundered into such accuracy, by perversion of their knowledge of Malaysia.

In the sixteenth century we have, however, admittedly no first-hand accounts of Australia by people who had been there. The records of European travellers to Australia begin early in the seventeenth century. The

famous expedition of de Quiros, which sailed from Peru on December 21, 1605, discovered the island of Espiritu Santo in the New Hebrides. The view, which has recently been expressed, that de Quiros reached the coast of Queensland, rests on no adequate evidence. Torres, one of de Quiros's officers, sailed through the Torres Strait, and first demonstrated that New Guinea was isolated from any land that lay to the south. In 1606 the Dutch records begin with the voyage of the *Duyfken* along the southern coast of New Guinea, and then southward for some distance along the western coast of the Cape York Peninsula, as far as Cape Turnagain, or Cape Keer-weer. The *Duyfken*, however, regarded Queensland as a southern extension of New Guinea, for Torres's work was not then known.

From 1616 to 1628 a series of Dutch expeditions explored the coasts of western Australia. In 1616, Dirk Hartog, in command of the *Eendragt* (the *Concord*), during a voyage from Holland to the Indies, visited Shark's Bay, and nailed a tin plate with a record of his visit upon a tree on an island, on the western side of Shark's Bay. His record was found there by de Vlaming, who removed the original and put up a copy, which was removed in 1803 by de Freycinet, who was in command of the *Casuarina*, one of the vessels of Baudin's expedition. Houtman sailed along the coast with a fleet of ships in 1619, and discovered the reefs which his sailors named "Frederik Houtman's Abrolhos," a contraction of the Portuguese words "abri vossos olhos," which mean "Keep your eyes open." The name was suggested by the dangerous character of the reefs, a fact which was illustrated by the wreck there of Pelsart's ship, the *Batavia*, on the 4th of June 1629. Houtman was followed by the voyage of the *Leeuwin*, which

rounded the south-western corner of Australia, now named Cape Leeuwin, and worked along the southern shore, as far as King George's Sound. In 1623 Carstensz and his vessels, the *Pera* and *Arnhem*, discovered Arnhem Land, the northern part of the Northern Territory of South Australia. John Edels explored the coast now known as Edels Land.

The southern coast, along the Great Australian Bight, was discovered by Pieter Nuyts, in the *Gulde Zeepaert* in 1627, and the name Nuyts Land was accordingly given to the country along the Bight, and to the Nuyts Archipelago in South Australia. In 1628 de Witt discovered de Witt's Land, which is now part of the Kimberley and north-western districts.

These Dutch voyages discovered the general outline of the coasts of northern and western Australia, as is shown by Abraham Goos's globe of 1621, and by a Dutch map, probably by Blaeu, published between 1629 and 1636, which has been described by Collinridge. This map gives a fairly accurate outline of the western coast, and of the southern coast, including the great Australian Bight. As this map calls Australia the "Terra del Zur," that name had probably been given previously by the Spaniards. The name Australia, written either as Australia or Austrialia, had been given by de Quiros in 1606, and it is spelt Australia by Purchas in 1625. In the same year the first British proposals for the colonisation of Australia were made to James I., but nothing came of this scheme, nor of the two great discoveries of Abel Tasman in 1642. Tasman pushed beyond Nuyts Land and discovered Van Diemen's Land, and crossing the Tasman Sea, was the first European to reach New Zealand.

In 1644 Tasman, with the *Zeemeeuw*, *Limmen*, and

De Brak, explored the north-western coast of Australia from Arnhem Land to Exmouth, and he first gave the name of Nova Hollandia, or New Holland, to the Australian continent.

British participation in the exploration of Australia began in 1688 with the voyage of William Dampier; he returned to the same district, under conditions more favourable for exploration, in 1699. In his second voyage to Australia, Dampier sailed along the north-western coast in the vain search for fresh water, or a convenient beach. "And thus," he wrote,[1] "having ranged about a considerable time upon this coast without finding any good fresh Water, or any convenient place to clean the Ship, as I had hop'd for; And it being moreover the heighth of the dry Season, and my Men growing Scorbutick for want of Refreshments, so that I had little Incouragement to search further; I resolved to leave this Coast, and accordingly in the beginning of September set Sail towards Timor." The popular interest in Dampier's visit has been increased by the general belief that he had discovered the occurrence of gold in Westralia, and named the north-western coast "Provincia Aurifera." It was in accordance with this belief that the first systematic search for gold in this district was undertaken by Calvert, in 1847. The genesis of this myth has been explained by Mr. C. H. Coote, of the British Museum. He points out that Dampier's Chart does not contain the name Provincia Aurifera, which first appears on some of the maps of the sixteenth century, such as Mercator's Globe of 1541 and his chart of 1569, and in Pieter Plancius's map of the world in 1594. Mr. Coote explains that "the whole

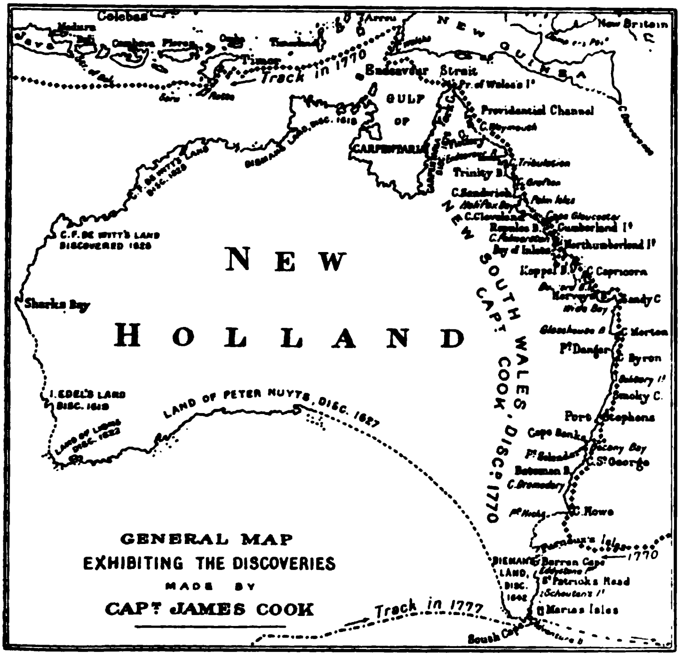
[1] William Dampier, *A Voyage to New Holland*, etc., in the year 1669, vol. iii. p. 154. London, 1703.

thing is a myth, and a geographical blunder of the first half of the sixteenth century." It arose from a mistaken quotation from Marco Polo, whereby the word "Locack," a Chinese name for a province in Lower Siam, was misprinted as "Beoach," beach; and "this," says Coote, "was ignorantly transferred by the early sixteenth-century geographers to an imaginary great southern continent, the north-west corner of which was supposed to be the two provinces of '*Beach*, *Provincia Aurifera*'—'*Maleteur* regum,' with '*Lucack* regum' repeated, in ignorance of the latter being the correct reading of *Beach*."

Dampier, therefore, did not discover the auriferous nature of Australia, and his description of the country as "the barrenest spot on earth," and of its natives as "the most miserable people, but little better than the brutes," discouraged interest in Australia; and it was not until nearly a century later that Cook and Banks's favourable accounts of the country first taught Europe to realise the possible economic value of Australia. Cook saw Australasia in the most favourable aspect she presents to the sea; for he circumnavigated New Zealand, and sailed along the whole of the eastern coast of Australia, from Point Hicks, on the southern coast of Victoria, to Cape York.

Cook's voyage in the barque *Endeavour*, during the year 1770, first discovered the eastern coast of Australia. After his circumnavigation of New Zealand, he sailed westward to follow the northern coast of the land discovered by Tasman in 1742. On the 17th of April he had got one degree farther west than the longitude assigned by Tasman to the eastern coast of Tasmania. So "at one in the morning we brought-to and sounded, but had no ground with 130 fathom; at six we saw land extending from north-east to west at the distance of

five or six leagues, having 80 fathom water with a fine sandy bottom. We continued sailing westward, with the wind at S.S.-W., till eight, when we made all the sail we could, and bore along the shore N.E., for the eastermost land in sight, being at this time in latitude 37°



AUSTRALIA, ACCORDING TO THE MAP OF CAPTAIN COOK.

58′ S., and longitude 210° 39′ W. The southernmost point of land in sight, which bore from us W. ¼ S., I judged to lie in latitude 38°, longitude 211° 7′, and gave it the name of Point Hicks, because Mr. Hicks, the first lieutenant, was the first who discovered it. To the southward of this point no land was to be seen, though

it was very clear in that quarter, and by our longitude, compared with that of Tasman—not as it is laid down in the printed charts, but in the extracts from Tasman's Journal, published by Rembrantse, the body of Van Diemen's Land ought to have bourne due south; and, indeed, from the sudden falling of the sea after the wind abated, I had reason to think it did. Yet, as I did not see it, and as I found this coast trend N.E. and S.W., or rather more to the eastward, I cannot determine whether it joins to Van Diemen's Land or not."

The Point Hicks which Cook first sighted was on the coast of Victoria, and has often been identified with Cape Everard. But it was a mere sand-hill, still marked on the Admiralty Charts as Point Hicks Hill, and it was not an actual projection of the coast. Cook sailed east along the Victorian coast, past Rame Head to Cape Howe, both of which he named; and then, turning northward, he followed along the coast of New South Wales, past Mount Dromedary, on the 19th of April 1770, Cape George on the 21st, and on the morning of the 22nd April he discovered Botany Bay. The bay was named on account of the richness of the vegetation; and during excursions inland it was found that the soil was even richer, and consisted of "a deep black mould, which," says Cook, "I thought very fit for the production of grain of any kind."

Among the adjacent woods, Cook adds, "We found also interspersed some of the finest meadows in the world." As there was also plenty of good building-stone, Cook regarded the place as well suited for a settlement. The harbour Cook described as "capacious, safe, and convenient." The expedition remained there till May 6, when it discovered Port Jackson.

At noon, May 6, 1770, "We were," says Cook,

"between two and three miles distant from the land, and abreast of a bay or harbour, in which there appeared to be good anchorage, and which I called Port Jackson." The name is popularly believed to have been given after the seaman who first saw the entrance; but there was no seaman of that name on board the *Endeavour*. The harbour was named after one of the officials of the Admiralty.

Following the coast northward, Cook was very favourably impressed with the country, which he says "exhibits a pleasing variety of ridges, hills, valleys, and plains, all clothed with wood."

The *Endeavour* was injured on a coral reef, and had an adventurous voyage along the Queensland coast to Torres Straits, through which the expedition returned home. Cook named the straits "Endeavour Streights," as, though the fact of Torres's passage through them had been discovered in 1762, after the British capture of Manila, it was still not generally known.

Cook's account of eastern Australia was cautious, but hopeful: "New Holland, or, as I have now called the eastern coast, New South Wales, is of a larger extent than any other country in the known world that does not bear the name of a continent. The length of coast along which we sailed, reduced to a straight line, is no less than 27 degrees of latitude, amounting to near 2000 miles, so that its surface must be much more than equal to all Europe. To the southward of 33° or 34° the land in general is low and level; farther northward it is hilly, but in no part can be called mountainous; and the hills and mountains taken together make but a small part of the surface in comparison with the vallies and plains. It is upon the whole rather barren than fertile, yet the rising ground is chequered by woods and lawns, and the

plains and vallies are in many places covered with herbage."

"If we may judge by the appearance of the country while we were there, which was in the very height of the dry season, it is well watered, for," Cook remarks, "we found innumerable small brooks and springs, but no great rivers; these brooks, however, probably become large in the rainy season."

Banks was slower than Cook to recognise the value of Australia. His first accounts of it, written during the voyage in his *Journal*, were very unfavourable. "In the whole length of coast which we sailed along," he says, "there was a very unusual sameness to be observed in the face of the country. Barren it may justly be called, and in a very high degree, so far at least as we saw. The soil in general is sandy, and very light; on it grow grass, tall enough but thin set, and trees of a tolerable size; never, however, near together, being in general 40, 50, and 60 feet apart. This, and spots of loose sand, sometimes very large, constitute the general face of the country as you sail along it, and, indeed, the greater part even after penetrating inland as far as our situation would allow us to do."

"Upon the whole," Banks continues, "New Holland, though in every respect the most barren country I have ever seen, is not so bad but that between the productions of sea and land a company who had the misfortune to be shipwrecked upon it might support themselves even by the resources that we have seen. Undoubtedly a longer stay and a visit to different parts would discover many more."[1]

But after Banks' return to Europe he formed a truer

[1] *Journal of the Right Honourable Sir Joseph Banks.* Edited by Sir Joseph D. Hooker. London, 1896, pp. 297, 307.

judgment. He had smelt the gum forest, and felt the charm of its bush. And gradually his heart warmed to Australia; from being less favourably disposed towards it than Cook, he became enthusiastic over it, and to his eloquence and his influence the first colonisation of Australia is due.

England had recently lost her American colonies; the attempts to found another white man's colony in West Africa had failed disastrously; and she was anxious to recover another extensive tract of temperate land for colonisation and convict settlements. Hence the accounts by Banks and Cook of the commercial value of Australia fell upon sympathetic ears. Cook had proclaimed the whole of the eastern coast of Australia as British, and at Banks' persuasions preparations were made for its occupation. On May 13, 1787, the first expedition left England for the establishment of a settlement at Botany Bay.

The chief literature on the early discovery of Australia is as follows:—

The classical and mediæval theories are best stated in Raymond's *Le Continent Austral.* Paris, 1893.

Records of the sixteenth and seventeenth centuries will be found in R. H. Major's *Early Voyages in Australia*; and there is, later, the still more convenient record in Collinridge's *Discovery of Australia*; see also S. D. Morgan, *Bibliographia of Australia* (1891).

Callander. *Terra Australis Cognita: Voyage to the Australis Terra.* London, 1763.

Heeres, J. E. *The Part bourne by the Dutch in the Discovery of Australia,* 1606-1765. London, Luzac & Co., 1899, pp. xviii and 106. Maps. 21s.

A summary of previous literature is given in Flinders' *Voyage to Terra Australis.* 1814.

The view that the reported discoveries of the sixteenth century are not authentic is advocated by Heawood, "Was Australia discovered in the Sixteenth Century?" *Geogr. Journ.* 1899, xiv. pp. 421-426.

Minor recent contributions to the literature of the early voyages include the following:—

Janssens, Ed. "La Participation des Néerlandais à la découverte de

l'Australie, 1605-1765," *Bull. Soc. R. Geogr. d'Anvers*, xxiv. 1900, pp. 83-92.

Morgan, E. D. "Notes on the Early Discovery of Australia," *Journ. Manchester Geogr. Soc.* (1892), pp. 238-244.

Hocken, T. M. "Abel Tasman and his Journal." [Includes first full translation of his log of his visit to New Zealand.] *Trans. New Zealand Inst*, xxviii. 1895 (1896), pp. 117-140.

Mault, A. "Note on a Manuscript Chart in the British Museum, showing Tasman's Tracks in the Voyage of 1642-44," *Proc. R. Soc. Tasmania*, 1894-95 (1896), pp. 27-33. Chart.

Shillinglaw, J. J. "Notes on an Original Chart of the South and East Coasts of Tasmania (supposed to have been constructed by Captain Tobias Furneaux)." *Trans. R. Geogr. Soc. Australasia* (*Victoria*), xvi. (1898), pp. 38-42.

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Norman, Henry W. "Captain Cook and his First Voyage round the World, 1768-1771; with special reference to his Exploration of the Queensland Coast," *Proc. and Trans. R. Geogr. Soc. Australasia* (*Brisbane*), xi. 1895, pp. 30.

Bonwick, James. *Captain Cook in New South Wales, or the Mystery of naming Botany Bay*, 1901, pp. 32. [An account of the various logs of Cook's voyage along the eastern Australian coast.]

The Brabourne Papers. Relating to the Settlement and Early History of the Colony: purchased from Lord Brabourne by Sir Saul Samuel, Agent General. [A summary of the contents.] London, 1886, pp. 48.

Macdonald, A. C. "Notes on the *Discovery of the Eastern Coast of New Holland*, by Captain Cook," *Trans. R. Geogr. Soc., Australasia* (*Victoria*), xiv. (1897), pp. 20-28.

Becke, Louis, and Jeffrey, Walter. *The Naval Pioneers of Australia*, 1899, pp. x and 314. Portraits and illustrations.

CHAPTER III

THE EXPLORATION OF AUSTRALIA

THE selection of Sydney as the first colony led to its being the earliest base of Australian exploration. The French were at first anxious to join in the work, partly from the spirit of scientific research, and partly from the desire to secure colonies in the Southern Hemisphere to replace those lost in America. For the first thirty years of Australian history French expeditions visited Australia, and showed a desire to annex part of the continent.

A few days after Phillip arrived in Botany Bay with the first British settlement (March 1788), a French fleet under La Perouse entered the bay. After a few days of friendly intercourse with Phillip, it sailed forth into the Pacific. What discoveries La Perouse had made on the Australian coasts are unknown, for after his departure from Botany Bay, he was never heard of again. An expedition under d'Entrecasteaux in the *Recherche*, and Huon Kermadec in the *Espérance*, visited Tasmania in 1792 in search of La Perouse. The names of d'Entrecasteaux Channel, the Huon River, and Huon Pine bear record to the work of this search party. From Tasmania it worked westward along the southern and western

coasts of Australia, where the Recherche Archipelago and Esperance Bay also derive their names from this expedition. It returned to Tasmania in 1793, and thence passed into the Pacific to search there for the lost

Photo. *J. W. Gregory.*

THE BLAZE OF THE VICTORIAN MINES DEPARTMENT

On a prospector's track through the forests of N.E. Victoria.

explorers. Meanwhile, the settlers at Sydney were making efforts to examine the country around their settlement. The convicts included men of enterprise and courage, who could well be trusted to undertake exploring work. According to Tenison Woods, the "colonists were selected in the most miscellaneous manner. Some, probably the majority, were political offenders, sent out

for offences of such a nature that society would have risked nothing to keep them at home." Phillip himself explored the adjacent hills, from those which he called the Carmarthen Hills on the north, through the Richmond Hills, to the Lansdown Hills on the south. The Blue Mountains were seen in the distance, but every effort to reach them failed.

1. The Earlier Coast Surveys

One of the most successful of the early inland journeys was the discovery of the Grose River, a feat accomplished by Bass, one of the twin heroes of this stage of Australian geography. Bass was a surgeon, who, from a passion for exploration, instead of entering medical practice, purchased a small vessel, with which he started to trade. His vessel was wrecked abroad, and Bass was forced to take service in the Navy, as a surgeon on board H.M.S. *Reliance.* He thus found himself at Sydney. His first opportunity for a few days ashore he spent in an expedition inland, during which he discovered the Grose River. The difficulties in the way of inland exploration were so great that it was neglected in favour of coastal survey. Bass, with his worthy companion Flinders, purchased a small 8-feet boat, which they called the *Tom Thumb,* and in which they started to explore the southern coast of New South Wales. Their first venture was to Botany Bay, whence they ascended the George River, for twenty miles beyond the previous records. In March 1796 they went still farther southward, and discovered Hat Hill. Bass then applied for help from the Government and, having proved his worth, was allowed the use of a whale boat, with a crew of eight men. He started in this open boat in December 1797,

and sailed down the New South Wales coast, discovering Shoalhaven, and the harbours Barmouth, Jervis, and Two-fold Bay; then he rounded Cape Howe, and passed Cook's Point Hicks, and along the Ninety Mile Beach, around Wilson's Promontory, and on westward to Western Port. Here the heavy swell which rolled in from the west, between the southern coast of the main-land and the north-eastern part of Tasmania, told him that he was not in a gulf, but in a strait, which completely separated Tasmania from the mainland. Failure of provisions compelled Bass to return to Sydney; but in October of the same year (1798), he and Flinders were sent back in the *Norfolk*, and during their circumnavigation of Tasmania they charted its coasts. In July 1799 Flinders was sent in the *Norfolk* to survey the northern coasts of New South Wales; he discovered the mouth of the Clarence River and Moreton Bay, in what is now Southern Queensland. In 1800 Lieutenant Grant, in a brig of 60 tons, named the *Lady Nelson*, sailed along the whole of the southern coast of Australia and through Bass Strait. This brig had an arrangement of three sliding keels, and had been invented by an Admiral Schank, whose name is preserved in Cape Schank, on which stands one of the chief light-houses on the Victorian coast. The *Lady Nelson* was not a success, and it took Grant eleven months to reach Australia; and though he tried several times to land on the southern coast of Australia, he failed at every attempt. He passed along the coast without discovering either the mouth of the Murray or Port Phillip. He noticed, how-ever, the great bight, from the head of which Port Phillip opens, and called it King Bay. In March 1801 Grant was sent from Sydney to survey Western Port, and while doing so, he landed on Churchill Island

and planted the first garden in the garden state of Australia.

Grant christened the capes and promontories along the coast, but contributed little to real knowledge of Australian geography. His work was at once eclipsed by the brilliant achievements of Flinders, who in the same year re-entered the field of Australian exploration. He had returned to England, and thanks to the influence of Banks, was given the command of an old sloop of 340 tons burden, which was refitted and renamed the *Investigator*. His staff included the famous botanist Robert Brown, and the artist Westall, to whom are due the beautiful drawings of Australian coast scenery in Flinders' work. The expedition started in July 1801, and reached King George's Sound in December. There they found traces of the sealers and whalers, who used it as a base during their work along this coast. From King George's Sound, Flinders carefully sailed along the Great Australian Bight. He examined its high limestone cliffs, and formed the quaint idea that this was the seaward edge of an upraised coral reef, behind which he expected the ground would be lower. On the eastern end of the Bight he lost a boat's crew at a cape which he therefore called Cape Catastrophe. Rounding this, he entered Spencer Gulf. As the coast trends far to the north, and a powerful tide swept past Cape Catastrophe, Flinders was inspired with the hope that he had discovered a strait which would lead northward to the Gulf of Carpentaria, and that Australia was an archipelago rather than a continent. But as he went northward the shores on either side closed in; the tide lost power, the sea became shallow, and Flinders was stopped at Port Augusta. He tried to work further northward in the ship's boat; but the gulf ended

in a mud-flat, and no river could be found flowing into it. Meanwhile Brown ascended the Flinders Range, and surveyed the country from its highest peak, Mount Brown. Flinders returned south, and visited Kangaroo Island, where it was clear, from the extraordinary tameness of the kangaroos, that the island had not recently been inhabited by man. Pursuing his course eastward, along the bight that forms the most easterly coast of South Australia, he met the French expedition under Baudin. The bight was accordingly named Encounter Bay. After exchanging news, Baudin and his two vessels, *Le Géographe* and *Le Naturaliste*, continued their course westward, and Flinders his journey eastward. The French expedition, whose work is commemorated in the names Cape Naturaliste and Géographe Bay, altered the names which Flinders had given to the area he had just explored. Thus they called western Victoria and the eastern part of South Australia Terre Napoleon; Kangaroo Island they called L'Isle Decrés; Spencer Gulf was rechristened Golfe Bonaparte, and St. Vincent Gulf, Golfe Josephine.[1]

Flinders entered Grant's King Bay, and with his usual thoroughness he discovered at its head the great harbour of Port Phillip, which he entered on the 26th of April 1802. It had been previously entered on the first of February 1802, by a seaman named Bowen, in charge of a boat belonging to the *Lady Nelson*. This brig was surveying in Western Port, under Lieutenant Murray, who, to confirm Bowen's discovery, entered Port Phillip on the 14th of February 1802. Murray named Arthur's Seat, from a fancied resemblance to the hill of

[1] Frequent protests against these changes have been made by English writers. Attention is less often called to the fact that many of the names given by d'Entrecasteaux's expedition have been supplanted by later ones.

that name behind Edinburgh; but he did much less than Flinders, who with his customary energy explored the southern part of the harbour, and ascended Station Peak, the highest summit of the You Yang Mountains, north of Geelong.

Flinders then proceeded to Sydney, and thence to a survey of the north-western coast of Australia. He discovered Broad Sound Bay, and Keppel Bay, the estuary of the Fitzroy River, which, according to Tenison Woods, "drains the largest and richest extent of country on the continent." He also surveyed Port Bowen and the long line of the Barrier Reef. He passed through Torres Strait, and on the 31st of October 1802 anchored at the Prince of Wales Island. Thence he turned southward into the Gulf of Carpentaria, which he hoped would be found to extend much further into the interior than it was represented to do on the Dutch charts. His old idea, that a southern gulf extended northward to join the Gulf of Carpentaria, still lingered in his mind. But he was soon undeceived. He made an excellent survey of the Gulf of Carpentaria, and passed Cape Arnhem into Melville Bay, which he named after the Lord of the Admiralty, whose misappropriation of funds was, according to Tenison Woods, the cause of the utter rottenness of the *Investigator*. The fact that the vessel was hopelessly unsound was discovered during this part of his voyage, and Flinders had hastily to complete the circumnavigation of Australia. At Arnhem Bay he discovered a fleet of Malay canoes, which had crossed from Timor, fishing for trepang. Flinders could not delay for much further survey work round the western coasts, and he reached Sydney on the 9th of June 1803. The *Investigator* was here examined and condemned. Flinders started back for England to get

another vessel from the Admiralty; but the merchant ship in which he sailed was wrecked on the Queensland coast; and so Flinders started home again in a 29-ton schooner. It had to call for repairs and stores at Mauritius, where Flinders was imprisoned by the French, and detained for six years. He was at length released, wrote his great work on *A Voyage to Terra Australis*, to a suggestion in which we owe the popular adoption of the name "Australia," instead of "New Holland." Flinders died on the day of the publication of his book, which is the greatest contribution to the coastal geography of Australia made by any one man.

Bass also came to an untimely end. After his voyage with Flinders round Tasmania, he took service as mate of a merchant ship, and crossed the Pacific to South America. There he was arrested, apparently treacherously, by the Governor of Valparaiso, and was never heard of again. It is generally supposed that he died a prisoner in the South American mines.

2. The First Explorations Inland

In the meanwhile, the settlement at Sydney had been growing, but the settlers had made no adequate attempt to explore the interior. A drought in 1813 rendered it imperative to find fresh pasturage in the mountains to the west. Three settlers, William Charles Wentworth, Gregory Blaxland, and W. Lawson, set out from Sydney to find a way up the sandstone cliffs that form the eastern face of the Blue Mountains. After many hardships, they found a spur which led to the surface of the plateau. They had further difficulties, owing to the irregularities of the plateau, and they feared that the divide might prove impracticable; but near Mount York

they found that the drainage was to the westward, and they knew that they had crossed the divide of the Blue Mountains, and that they had found the road to the west. They returned to Sydney with the good news, and a Government expedition under the Deputy Surveyor, Evans, was sent to follow up their work. Evans crossed the Nepean River on the 20th of November 1813, climbed on to the Blue Mountains along the track of his predecessors, crossed the divide, and followed the Fish River in its descent westward into the Macquarie River. He continued along this river over wide level plains, rich in game. After his return to the coast, a road was built across the mountains, and was finished, as far as the site of Bathurst, in 1815. Evans was despatched on further explorations in the west. Whither the Macquarie flowed was a mystery the colonists were anxious to solve; and the mystery was heightened when Evans discovered the Lachlan, another large river, flowing westward into the interior. It was believed that Flinders' survey rendered it certain that no big river discharged to the sea on the southern coast of Australia. So Oxley was sent, in 1815, to trace the Lachlan to its end. Oxley followed its course till further progress was rendered impossible by the entry of the river into a vast swamp. To round it, Oxley struck southward across the plains. He almost reached the Murrumbidgee, but being short of water, he returned north-west, a few miles too soon. Had he kept southward for another day he would have found the Murrumbidgee, and would have had a good chance of achieving his object, and reaching the southern coast. He again followed the Lachlan westward, but again it spread out into swamps and vast impassable marshes. He struck north across the plains to the Macquarie, and then south-eastward along it, and so back to Bathurst. He told a

dismal tale of the interior. He was emphatic that the rivers had no outlet on the southern coast, and that they were all lost in vast swamps in the interior.

In 1818 Oxley was sent on his second journey. He boated down the Macquarie river till he could go no further. He discovered Mount Harris. He concluded that the swamps into which the Macquarie passed were the edge of a great inland freshwater sea; but he could not force his way through the swamps, and had to return. He was convinced, however, that "If an opinion may be hazarded from actual appearances, mine is decidedly in favour of our being in the immediate vicinity of an inland sea or lake."

During Oxley's return journey he had much trouble in the labyrinth of gorges about the Apsley River; with great difficulty he crossed the northern plateau to Sea View Mountain, whence he reached the coast, and followed it southward to Sydney. The main result of this expedition was the discovery of the Liverpool Plains and the plateau of New England, though they were too difficult of access to be of any service to the colony at that time.

3. Completion of the Coast Survey

The western coast of Australia was still unsurveyed, and a son of Governor King, Captain P. P. King, who had been born at Norfolk Island, was sent in the *Mermaid*, a cutter of eighty-four tons, to undertake this work. He left Sydney on the 22nd of December 1817, and was accompanied by the botanist Allan Cunningham. King had to survey the north-western coast from Arnhem Bay, where Flinders had stopped systematic work, to the known regions of the western coast. He began work at

Cape North-West, in May, and surveyed Exmouth Gulf and some parts of the adjacent coast. On his return to Sydney, he was sent to survey Macquarie Harbour in Tasmania, and then, in May 1819, he went on his second expedition to the north-western coast. His third voyage was in 1820, when he surveyed the fiords of the Red Coast, the most interesting part of the north-western coast. His fourth and last voyage was during 1821-1822, in the brig the *Bathurst*, when his survey of the coast-line between Arnhem Bay and Bathurst Island, and of parts of the north-western coast, during which he named Roebuck Bay and the Buccaneer Archipelago, completed the survey of the Australian coast-lands.

4. Exploration of South-Eastern Australia

After this date, interest centres in the attempts to explore the interior and to colonise the coast-lands. As the work of Oxley and Evans had shown the general nature of the country due west from Sydney, exploration was next directed to the south-west. The first important progress in this direction was the discovery by Currie and Ovens, in 1823, of the Murrumbidgee, which had been so nearly reached by Oxley. In October 1824, an expedition under Hamilton Hume (who in 1817 had discovered Lake Bathurst, near Lake George), and Hovell, conducted at the joint expense of the two explorers and the Government, started to cross the southern parts of New South Wales to Western Port. In the first part of the journey the expedition was entangled in the rugged mountains of the New South Wales Highlands; and it was not until the explorers were driven from the hills on to the plains that they made much progress. They crossed the Murrumbidgee by using their waggon as a boat; but

it had to be left behind, before they reached the Murray, at Albury. So they ferried their stores across that river in a boat made of wicker-work and a tarpaulin. This river was named the Hume, in honour of the father of the leader of the expedition. Hence they continued south-westward, still in sight of the snow-clad mountains, which they had called the Australian Alps; they passed Mount Buffalo; they crossed the Ovens and the Goulburn, and finally got entangled amongst the forests of King Parrot Creek, and were driven back from Mount Disappointment. Thence they saw the mountain which they named Mount Wentworth, but which is now known by the later name of Mount Macedon. They crossed the main Victorian divide near Seymour, and reached the coast near Geelong on the 18th of December. Hovell maintained that they had arrived at Western Port, and as he, having been ship's captain, was the surveyor of the expedition, his view was generally accepted. This mistake delayed the settlement of Victoria for some years: for Hume's glowing account of the fertility of the coastal plains led to the despatch of an expedition from Sydney to colonise them. In accordance with Hovell's view, the expedition went to Western Port, which was found inferior to Hume's description, and the settlement was abandoned in disgust.

While Hume and Hovell were working southward, efforts were being made to utilise the earlier discoveries in the north, and to develop the country to the north of Sydney. In 1823 Cunningham, who was employed as a botanical collector by Kew Gardens, found a practicable road to the Liverpool Plains. The same year Oxley explored the Brisbane River, believing that it would be found to drain the inland sea which he thought he had discovered in 1815. This theory of the origin of the

Brisbane River was shown to be incorrect by Cunningham. In 1827 he started from the Upper Hunter, discovered the Gwydir and Dumaresq Rivers, and followed the Brisbane River to its source. During this journey he discovered the Darling Downs, whose rich grass-lands subsequently brought prosperity to Southern Queensland. The Darling Downs were, however, apparently cut off from the coast by the precipitous scarp which forms the western boundary of the coastal districts. Cunningham discovered a gap, which he thought would prove a practicable pass, from Moreton Bay on to the plateau. The next year (1828) he started from Moreton Bay and climbed Mount Lindsay, but failed to reach his gap. A second attempt, from Ipswich on the Bremer River, was successful; and on the 25th of August 1828 he found the only available pass from the coastal district around Brisbane on to the rich downs of Southern Queensland.

The work of the coast surveyors and of the early inland explorers tended to show that Australia was saucer shaped, having a mountainous girdle a short distance back from the coast, and then a long slope downward into the interior. The mountain girdle in places fronts the ocean in lofty cliffs, as on the Red Coast of the north-west, near Illawarra in New South Wales, and near Cape Jervis; but it is usually separated from the shore by a coastal district, which may be from 20 to 30 miles in width, as at Sydney, or so wide that the mountain summits can only be observed from the coast in the dim distance. Even where no definite proof of the mountain girdle was known, its existence was probable; for Hume and Hovell found that the plains near the Victorian coast were bounded to the north by a tract of highland country. The mountain

girdle was known to be only a few thousand feet in height, and a very gentle slope from the highlands to the vast interior would place Central Australia below sea-level. Hence it was thought that the depression might be filled with an inland sea, maintained by the rainfall on the coastal ranges. Flinders' theory that a lagoon lay behind the limestone cliffs of the Australian Bight; the frequent flight of water-birds from Sydney westward into the interior; and the existence of the vast swamps that stopped Oxley, all helped to strengthen this belief. Oxley, however, had visited the interior during a period of exceptionally heavy rain, and it was thought desirable to re-examine the district during a period of drought. A drought of sufficient intensity occurred in 1828, and Sturt, who was one of the champions of the inland sea theory, was sent to discover what Oxley's swamps and inland sea were like under different conditions. Sturt was ordered to go down the Macquarie River and follow it to its mouth; and if he reached any sea or inland swamps, he was to round them to the south and west. Sturt started in September 1828, and Hamilton Hume, the hero of the great overland journey to Port Phillip, accompanied him. Mount Harris, on the edge of the unexplored country, was used as the base of their operations. The geographical conditions were found to be very different from those at the time of Oxley's visit. There were a few isolated lakes, but the Macquarie River diminished in volume, and disappeared on the plains. The expedition continued westward, and reached the edge of a deeply entrenched river. On reaching the water to drink, it was found to be salt. Hume discovered a freshwater pool which saved the expedition, and Sturt returned with an ill report, describing Central Australia as a desert, watered by rivers of brine.

At both places where Sturt had reached the Darling, it was flowing westward; and it was still possible that it might enter an inland sea, yet further to the west. Sturt claimed that the saltness of the river was due to mixture with sea water, though a simple chemical analysis would have disproved this hypothesis. To test his idea, Sturt was sent westward again in September 1829, to follow the Murrumbidgee. The description of this river showed that it had a more powerful and steady current than the Macquarie, and it might be expected to have a longer course. He followed beside the Murrumbidgee for some distance in a cart; then launching his whale-boat, he rowed down the river, past its junctions with the Lachlan and with the Murray, and then found that it was joined by a river which he rightly concluded must be the Darling. He reached Lake Alexandrina, and saw the single outlet by which the Murray waters reach the sea; but he considered the mouth useless for navigation, and his account led men to believe that the outlet was probably not always in existence. Disappointed with the ending of the Murray, Sturt and his men rowed back up the river to their launching-place, and thence marched overland to Sydney.

The country to the west of the Lower Murray was first explored by Captain Barker, who, in 1831, landed near Adelaide and ascended Mount Lofty. Thence he continued eastward to Lake Alexandrina, to examine the mouth of the Murray. He found that it was only a quarter of a mile in width, and he swam across it to examine its eastern shore. His men watched him walk up a sandhill, and he was never seen again. He was, no doubt, killed by the aborigines.

The endings of the Murrumbidgee and the Lachlan were known by Sturt's work, but the fate of the Darling was not yet certainly determined; for between the

Lachlan and the Bogan, the westernmost important tributary of the Darling, there was known to be a belt of old rocks rising above the general level of the Western Plains. This belt includes the mining field of Cobar, and it is continued westward, from the M'Culloch Range, through the Wilcannia and Barrier Ranges, into South Australia. This area of old rocks, no doubt, formed the coast of the sea which in Cretaceous times extended southward from the Gulf of Carpentaria into Central Australia. It still has some of the characters of a main divide; and some Australian geographers thought that it probably divided the basin of the Darling from that of the Lachlan and Murrumbidgee. This view was supported by the reports of an escaped convict, who said that he had found a river flowing northward from the Upper Darling basin towards the northern coast.

Sir Thomas Mitchell, afterwards Surveyor-General of New South Wales, was accordingly sent, in November 1831, down the Peel River to the Upper Darling, to see whether this report were true. He followed the Peel River to its junction with the Darling; but on this occasion was unable to travel far to the west, and he found nothing to confirm the convict's false report. Mitchell started again in March 1835: he reached the Darling further to the west, and followed it along the valley it has cut through the old divide, and nearly reached its junction with the Murray. He discovered that the river was fed by a series of local springs in its bed, so that it was alternately fresh and salt. His expedition cost the life of the botanist Richard Cunningham (brother of Allan Cunningham), who wandered away from the expedition to an aboriginal camp, where, having become mad and delirious, he was murdered by the frightened aborigines.

As Mitchell's second expedition had not actually reached the junction of the Darling and the Murray, he started in March 1836 on probably the most important expedition in Australian history. He reached the confluence of the Darling and Murray, and he followed the latter eastward to Swan Hill, whence he marched across western Victoria to the southern coast. He reached Portland Bay, where he found that the Hentys had established a whaling station. He returned north-eastward across Victoria, and thence back to New South Wales. This journey not only settled the final question in regard to the Murray-Darling river system, but it was the most important single contribution ever made to the inland geography of Victoria. Mitchell discovered, amongst other mountains, the Grampians, where he spent one night on the summit of Mount William, and the Pyrenees; he named Mount Macedon, from the summit of which he looked down on Port Phillip; amongst the rivers which he first saw and named are the Loddon, the Avoca, the Campaspe, and the Coliban. Mitchell was enchanted with the beauty and fertility of western Victoria. He was so charmed with the country that he named it Australia Felix, and his glowing enthusiasm led to its settlement, which was begun immediately after his return.

Adelaide was founded in 1836, and from it the structure of the country between St. Vincent's Gulf and the Murray was soon discovered. Cook and Finlayson crossed the Mount Lofty Ranges and reached Lake Alexandrina, and their reports strengthened the idea that the Murray was not always open to the sea.

The development of Victoria, then known as Port Phillip Settlement, was rapidly begun after Mitchell's return. The overlanders, Hawdon, Bonney, and Eyre,

drove flocks westward to reach the settlement at Adelaide. Hawdon got his through first. Eyre, taking a more northerly course, showed that the Wimmera, the westernmost river on the southern side of the Murray, occupied an area of internal drainage; for, after passing through Lake Hindmarsh, it dried up in the area known as Lake Albacutya.

5. The Exploration of North-Eastern Australia

The north-eastern quarter of Australia was the next area to be explored. The Queensland coastlands were examined from the coast settlements. The great inland journeys were begun by Leichhardt's first expedition, which started in October 1844. Its object was to open up a road from Moreton Bay (now in Southern Queensland) to Port Essington. He struck north-westward, and discovered the Suttor and Burdekin Rivers; he then crossed to the valley of the Mitchell, and passing to the south of the Gulf of Carpentaria, reached the Roper River, and crossed the peninsula of Arnhem Land, to Port Essington.

The expedition involved the loss of the naturalist Gilbert, who was killed during an attack by the aborigines. The journey occupied fifteen months, and the arduous nature of the march and the abandonment of Port Essington in 1850 rendered the expedition economically fruitless.

The problems of north-eastern Australia induced Sir Thomas Mitchell, whom Tenison Woods justly calls the most successful of Australian explorers, to take the field again. In 1845 he started on the last of his three great expeditions. His plan was to cross from the back blocks of New South Wales to the Gulf of Carpentaria,

in order to determine the position of the watershed between the tributaries of the Darling and the rivers that flow into the Gulf of Carpentaria. He discovered further tributaries of the Darling, and also the Belyando River, which he followed northward in the hope that it would lead him to the Gulf of Carpentaria; but as it went too much to the east, he left it, and reached the Upper Barcoo, which he called the Victoria River. He concluded that the Barcoo flowed to the north-west, into the Gulf of Carpentaria; and though he was wrong in this conclusion, his expedition had important results, for it discovered a region of first-class pastoral country, which Mitchell declared was "sufficient to supply the whole world with food."

In 1847 Kennedy was sent out to settle the course of the Barcoo, and see whether it might not be the upper part of Cooper's Creek, as it proved to be.

Mitchell's last expedition formed the starting-point of Leichhardt's last. He started, in August 1847, from the Darling Downs for Cogoon (lat. 26° 53′) in the Fitzroy Downs, which he intended to use as a base for work further to the north-westward. But he kept 15 miles too far to the south, and so failed to find Fitzroy Downs. Undaunted by his failure, which was probably due to the defective eyesight which made him a poor bushman, Leichhardt started again on the ambitious project of crossing the Continent from east to west. This time he managed to find the Fitzroy Downs, and started thence, from M'Pherson's Station, on the 3rd of April 1848. His expedition was never heard of again, and its disappearance is the greatest mystery in the annals of Australian exploration. Abundant search was made for him. Hely heard a circumstantial account of the massacre of his expedition, but the story is generally

discredited. Walker found some trees marked *L*, from which he inferred that Leichhardt had crossed to the south of the Gulf of Carpentaria into the Northern Territory. But the *L* blaze was probably that of Landsborough. A. C. Gregory in 1858 found two of Leichhardt's camps on the Barcoo, and that was the furthest westward to which he has been traced. Search was made for traces of him in Westralia by J. Forrest in 1869, and renewed search has been recently proposed by Dr. Laver. But it appears most improbable that Leichhardt could have crossed the now well-known line of the Overland Telegraph, without some trace of him having been found there. He had a considerable equipment, and if he had been murdered by the natives, or perished on the plains through lack of water, some of the metal in his oufit or his tools should have been found by the aborigines, and subsequently seen by travellers. His fate has been the subject of the wildest speculations. It has been claimed that Leichhardt reached the Northern Territory, owing to the asserted resemblance to him of a half-caste child, who might have been born about 1850. The most probable explanation is that the whole of his party and equipment were swallowed up by the widespread floods that at times come down the Diamantina.

The project of establishing an overland route from Sydney to a port on the northern coast, that would be convenient for trade with the Indies, which had inspired Leichhardt's first expedition, was responsible for Kennedy's disastrous expedition of 1848. He was landed at Rockingham Bay by H.M.S. *Rattlesnake*, and thence tried to march north-westward. The swamps and dense jungle, with the twining calamus, rendered progress very slow, and the natives were hostile. So Kennedy was forced back to the coast at Princess

Charlotte Bay (14° 30′ S.), where a boat was to call in case he happened to go there; but he arrived too late for the boat, so he and some of his men started northward overland to Cape York. On the way he had to leave his companions in a depot, and Kennedy, with an aboriginee, continued the journey to Cape York. Near his destination Kennedy was killed by the blacks, who also stormed the camp in which he had left his companions.

The traverse of Northern Australia, which Kennedy attempted, was successfully accomplished in the late Sir A. C. Gregory's expedition of 1855-56, for which the British Government contributed £5000. The expedition consisted of eighteen men, including H. C. Gregory as second in command, and Baron von Mueller as botanist. The expedition landed at the mouth of the Victoria River, on the north-western coast, as it was hoped this river would lead to the centre of the Continent. The expedition started on the 6th October, and followed the Victoria River into the plateau of the Northern Territory, Gregory noticing on the way that the Macadam Range was only the deeply serrated edge of the sandstone tableland. Finding no practicable road, Gregory returned to his camp on the coast; after various minor trips inland, he started with nine men, on the 3rd of January 1856, and worked southward and south-westward across the Kimberley Goldfields and Sturt Creek to a large salt lake, known as "Gregory's Salt Sea"; thence he returned, after a journey of five months, to his depot on the Victoria River. After a short rest, he started again on the 21st of June, marched across the Northern Territory to the valley of the Roper River, passed to the south of the Gulf of Carpentaria, struck north-eastward into Queensland as far as the

Gilbert River, and then continued along it, and southward along the Queensland Highlands, to the coast at Port Curtis. This great journey Tenison Woods describes as "one of the finest, most extensive, and yet most expeditious explorations which had ever taken place in Australia."

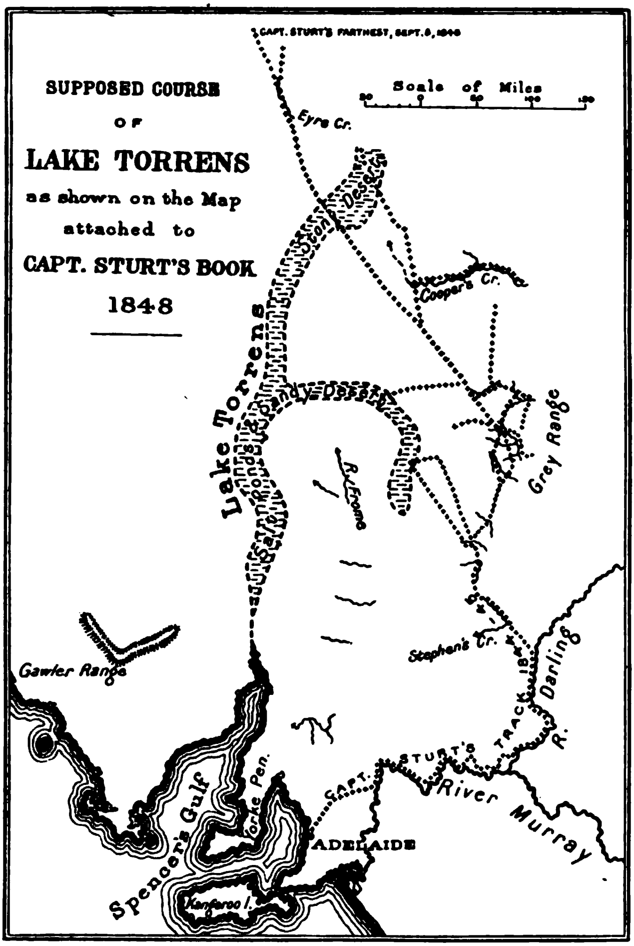
A. C. Gregory made another of his rapid traverses in 1858: he was sent to join in the search for traces of Burke and Wills; he marched overland from Brisbane to Adelaide, down the Barcoo, found two of Leichhardt's camps and traces of the vast floods which sometimes inundate that country; and by crossing over the supposed western arm of Lake Torrens, he showed, as suggested by Babbage in 1857, that it is founded on a series of distinct lake basins.

6. The Traverse of Central Australia

The eastern and western traverse of the Continent has proved less fascinating than that from north to south. This quest was begun in the earliest days of inland Australian exploration, by Eyre's attempts from the head of Port Augusta. He followed the South Australian Highlands northward, till he was stopped, both to the north-north-west and the north-east, by a band of salt lakes and salt swamps; he regarded them all as part of a horseshoe-shaped lake, Lake Torrens, which he thought surrounded the South Australian Highlands on all sides but the south; being unable to cross this lake, he passed to the southward of Lake Torrens, and started on his great journey round the Great Australian Bight to Albany and Perth.

Eyre was followed by Sturt, who tried to get inland by keeping to the eastern side of the supposed eastern

arm of Lake Torrens; so he started from Menindie on



LAKE TORRENS, ACCORDING TO STURT.

the Darling. He made a branch excursion westward to Lake Blanche, which he accepted as part of Lake

Torrens, and then marched north-westward to Cooper's Creek; he crossed the Diamantina without recording it on his map, and was turned back by the Stony Desert to the north of it.

Sturt's account kept men from trying this route again for another decade. But the expeditions of Horrocks, Oakden, and Hulkes made some minor discoveries around Lake Torrens; but nothing important in this area was achieved until 1856, when Babbage reached Blanchewater, and rendered it probable that the supposed western arm of Lake Torrens was a series of separate lakes; and this fact was proved independently by Parry, Stuckey, and A. C. Gregory in 1858. Babbage's work called fresh attention to the north-eastern part of the South Australian Highlands; and great expectations as to the value of this country were roused in 1857 by the sensational accounts by Goyder of his discovery there of a vast permanent freshwater lake. Freeling was at once sent off with a boat to navigate this inland sea; but most of it had dried up before he got there: he could not find any water more than six inches deep in which to float his boat, and he showed that some of Goyder's descriptions were founded on mirage.

In the same year, Babbage was making a detailed survey of the area to the westward of Lake Torrens, and thus led to the discovery that the lake now known as Lake Eyre is distinct from Lake Torrens. He named it Lake Gregory, after his second in command; but Babbage's work was discredited by the South Australian Government, and the name of Lake Eyre, proposed in an anonymous article in the *South Australian Register*, was adopted. Babbage discovered the Mound Springs on the edge of Lake Eyre basin, and the marine Cretaceous fossils in the marls outcropping on its shores.

Further progress northward, to the west of Lake Eyre, was made in 1858 by Parry and J. M'Douall Stuart, who had been draughtsman with Sturt in 1844-45.

Stuart's first independent expedition was in 1858, when he explored the area now known as Stuart's Creek to the south of Lake Eyre; he returned to Adelaide past Lake Gairdner to Streaky Bay. In 1859 he conducted two short expeditions, in which he pushed further northward along the western shore of Lake Eyre. In March 1860, Stuart started on his fourth expedition, in which he worked far to the northward of Lake Eyre, discovered Chamber's Pillar, the Waterhouse Range, and the Macdonnell Range, and the mountain which he regarded as the central point of Australia, and called Central Mount Stuart. Why he regarded that locality as the centre of the Continent it is not easy to understand. He pressed on northward, till a skirmish with the aborigines and the difficult nature of the country compelled him to return, when only 250 miles from the northern coast of Australia. This brilliant journey secured for Stuart adequate help from the South Australian Government; and he started north, in January 1861, on his fifth expedition. He broke his former record by about 100 miles, but impenetrable scrub and rugged country foiled him once more. On his return to Adelaide the Government equipped him again; and in October 1861 he started on his sixth expedition, during which he crossed the Continent to the Adelaide River, and followed it north to the shore of Van Diemen's Gulf.

While Stuart was at work on the route now used by the Overland Telegraph, the Burke and Wills expedition in 1860-61 was effecting the first crossing of the

Continent, by a route to the east of Lake Eyre. The expedition was fitted out by the Victorian Government, and it was the first occasion on which camels were adopted as the main transport of an Australian expedition. Thanks to the camels, Burke, Wills, Grey, and King crossed the Continent to the shore of the Gulf of Carpentaria; but, owing to the mismanagement of the expedition, Grey died on the return march, and Burke and Wills perished on the banks of Cooper's Creek. One survivor, King, was rescued by Howitt, and thus verbal records of the work of the expedition were obtained. The scanty notes of the expedition were so unintelligibly written, that the handwriting experts of the Victorian Law Department deciphered them with difficulty.

The tragedy of their needless fate has gained Burke and Wills wider fame than that perhaps of any other Australian explorers. But their expedition was mainly of value indirectly, from the brilliant contributions to the geography of Central Australia made by the various search parties. Howitt twice explored the Cooper's Creek district; for, after his rescue of King, he was sent back to collect the bones of Burke and Wills for burial in Melbourne.

M'Kinlay, who was sent in 1861 by the South Australian Government to help in the search, crossed from Stuckey's Crossing, between Lakes Blanchewater and Gregory, and followed up Cooper's Creek; he found Grey's body, and heard that the whole expedition had been massacred. This story was either an invention of the aborigines, or a distorted account of the possible fate of Leichhardt. M'Kinlay pushed on northward to the Gulf of Carpentaria, and thence crossed eastward over Queensland to Brisbane. His reports, combined with

those of Davis, Stuart, and Howitt, were of great importance, as showing that the Lake Eyre district, in favourable seasons, contains excellent pasturage. M'Kinlay and his assistant, Davis, described Sturt's Desert as a fertile country of lakes and meadows.

Landsborough, who had been sent to the Gulf of Carpentaria by sea, to search for Burke and Wills, explored the Albert River, but found no signs of the lost explorers; but, starting with meagre stores and equipment, he marched southward, discovered the position of the divide between Lake Eyre and the Gulf of Carpentaria, and followed the Barcoo to the known country; thence he struck off eastward and reached Menindie on the Darling, by a new route down the Warrego.

The Macdonnell Range discovered by Stuart was, in 1894, the centre of the field of work of the Horn expedition, the most important scientific expedition in the records of Australian exploration. The area to the north of the Macdonnell Chain, along the frontier between Westralia and South Australia, was explored in 1900 by R. T. Maurice.

7. The Exploration of Western Australia

The explorations of the vast arid interior of Western Australia may be divided into three main series—(1) those in the southern division of the State, between the present road to the main goldfields and the southern coast; (2) those along the oft-traversed trans-continental road, across the middle of the Continent to South Australia; and (3) those on the route northward to the Kimberley Goldfields.

The country to the south-eastward of Perth was

explored in 1835 by J. S. Roe, who crossed to Albany, and twice traversed the Stirling Range.

The first attempt to get far inland, eastward from Perth, was by J. S. Roe in 1836, who then discovered Lake Brown, on the western edge of the Yilgarn Goldfield. His record was beaten in 1846 by the three brothers, A. C., F. T., and C. Gregory. It was an official expedition, the Government having contributed £5 to the expenses! The explorers paid the rest. They started from Bolgart Spring, got well into the Yilgarn Goldfield, beyond Mount Jackson, and on their return journey they discovered some coal-seams in the Ainsworth Valley (lat. 28° 57′ S., 115½° E.). F. T. Gregory was sent in the following year to determine the extent of the coal.

Coolgardie was first reached by H. M. Lefroy in 1863; he was looking for pastoral country, of which he said there was ample, though it had no water. He did not notice any sign of the mineral wealth of the field.

In the following year C. C. Hunt travelled still further eastward, crossing the Hampton Plains, and the districts of both Coolgardie and Kalgoorlie, to 121° 55′ east.

Eyre's route round the Great Australian Bight was first again traversed in 1870 by Sir John Forrest. The country behind the coast from Albany to the Recherche Archipelago and Cape Arid had been explored by Roe in 1848, who then discovered the coal-beds of the Phillips River; but nothing further was done till Sir John Forrest's expedition. He started from Perth on a south-easterly route across the country to the west of the route now followed by the Albany Railway; he reached Broome Hill, where he turned eastward to the shore of the Great Australian Bight. He continued along the coast to

Esperance Bay, and on to the South Australian frontier at Eucla. There he explored inland, and found what would be first-class pastoral country, if it had a supply of surface water. From Eucla he continued eastward to Adelaide. No other expedition, dependent on horse transport, has ever again crossed Australia from west to east.

In 1871 Alexander Forrest travelled inland from Perth through Southern Cross to East Coolgardie; thence he went southward across the hitherto untraversed country between Coolgardie and the southern coast; he returned through Esperance Bay.

The first explorer to accomplish the journey from Adelaide to Perth by an inland route was Ernest Giles, in 1875. He had previously made two attempts to cross with horses; but in both cases lack of water drove him back, on one occasion after the loss of his companion Gibson, in the Gibson Desert. In his third expedition he was provided with camels, and was able to accomplish the journey with comparative ease. He left Port Augusta on the 23rd of May 1875, and crossed the frontier between South and West Australia, near the locality known as Boundary Dam; he crossed a long tract of waterless country to Queen Victoria Spring, and having re-watered there, he passed across the northern part of the Kalgoorlie Goldfield to Ullaring, and thus reached Perth. In his return journey he crossed Western Australia again, by a northerly route; he travelled through the Murchison district, and thence marched eastward to the north of the Sutherland Range, and entered South Australia through the district of the Macdonnell Chain.

In 1891 David Lindsay traversed the desert country between the Musgrave Range and the southern route.

Lindsay was in command of an expedition fitted out by Sir Thomas Elder; it started from Warrina, to the west of Lake Eyre, and went north-westward past the Tomkinson Range, and continued westward, along Giles's return route, to Mount Squires. Thence Lindsay struck south-westward to Queen Victoria Spring, where he reached a well-known route to the coast.

Mason, in 1896, further explored the country behind the Australian Bight. He crossed overland from Kalgoorlie to Eyre, and then struck inland again north-eastward to the South Australian frontier, and southward along it to Eucla. His reports agree with those of Sir John Forrest as to the excellence of the pastoral country in this region, but for the absence of water.

In 1901 the country between Kalgoorlie and Eucla was surveyed by John Muir, in the search for the best route for the Trans-Continental railway which is proposed to connect the Western Australian railways from Kalgoorlie, *viâ* Eucla, with the South Australian railway at Port Augusta.

The exploration of the middle belt of Western Australia through the Murchison and Mount Margaret Goldfields began in 1848, with A. C. Gregory's expedition up the Murchison River, which resulted in the discovery of the lead-mines of that area, and in his report of the existence of pastoral country. The next important progress along this route was during Austin's expedition of 1854; he travelled up the Murchison River, into the Gascoyne district, and reached Mount Magnet; but the failure of the horses, which were poisoned by eating the box-plant, and lack of water, prevented him penetrating further eastward than 115° 16′. Austin predicted that the country round Mount

Magnet and Lake Austin would prove to be one of the finest goldfields in the world. The present mining centres of Cue and Day Dawn show that his opinion that the country is auriferous has been justified.

In 1866 E. T. Hooley explored the country further to the north; he started from Geraldton on a north-westerly course up the Murchison River, and crossed the north-western corner of Westralia to Roebourne. The next progress eastward was achieved in 1869, by Sir John Forrest, who was sent eastward, on the chance of finding some trace of Leichhardt's expedition. He got inland as far as lat. 122° 50′ east, discovered Mount Margaret, and passed the site of Laverton, and explored parts of the goldfields round Leonora and Mount Margaret.

The route from the Murchison district to South Australia *viâ* the Musgrave Ranges was opened up by work from both sides. The Musgrave Ranges were reached by Giles and Gosse in 1873, and used as a base for an advance westward; but both explorers were driven back by lack of water, and of food for their horses. In 1873 Warburton, provided with camels, crossed from Alice Springs to Roebourne.

In 1874 Sir John Forrest achieved the journey from the west. He started from Geraldton, marched up the Greenough River, and then crossed its watershed into the Murchison River. He continued westward to the Robinson Range, near Peak Hill, and then turned south-south-eastward to Mount Russell on the Peak Goldfield, and then north again to the Weld Spring; thence he struck eastward across waterless desert to the Alexander Spring, at the foot of the Sutherland range, and continued eastward till he reached the routes of Giles and Gosse, which he followed into South Australia.

Further light was thrown on the head-waters of the Gascoyne and the Ashburton Rivers by an expedition under Favenc in 1889. The country to the south-west of the Sutherland Range was explored in 1891-92 by Sir Thomas Elder's expedition under D. Lindsay; its work connected the route through the Musgrave Range and the southern road, by a journey from Mount Squires south-westward to the Queen Victoria Spring. Lindsay also explored the country to the west of the Sutherland Range, and reached nearly as far westward as Nannine, returning across Lake Darlôt.

In 1896 the South Australian Government fitted out an expedition under Hübbe, to open a stock road from the South Australia railway terminus at Oodnadatta to the Westralian Goldfields. Hübbe followed the Musgrave Ranges to the Sutherland Range, and thence struck south-westward past Lake Wells to the goldfields at Mount Margaret. The country to the south of Hübbe's route was explored by a prospecting party under H. Russell in 1897. He travelled from Mount Margaret to Mount Squires by a new and direct route, passing 70 miles to the south of the Sutherland Ranges.

In 1903 F. H. Hann started from Laverton, and marched on a line parallel with that of Russell and still further to the south. He crossed to the Warburton Range by a new route, to the west of Mount Squires, and reported the road to be practicable for stock; and much of it, he found, was well watered.

The exploration of the northern section of Westralia followed four main lines: (1) the overland route across the north-western corner, from Geraldton, or other west coast ports, to Cossack Bay and Roebourne; (2) the exploration of the eastern part of the Pilbarra Goldfield

by journeys up the de Grey River, from the coast at Roebourne or from Port Hedland, or from the overland route from Geraldton; (3) the exploration of the Kimberley division in the extreme north of the State; and (4) the overland journeys from the Murchison or Mount Margaret Goldfields to the Kimberley district.

The north-western corner of the State was first explored by Frank Gregory in 1858. He followed up the Gascoyne River, and then crossed the Ashburton basin and the Hammersley Range to the Fortescue River, and thence to the coast at Roebourne.

E. T. Hooley followed in 1865-67; he started further to the south, went up the Murchison River, and then, to the west of Gregory's route, crossed the upper part of the Wooramel River and the head-waters of the Ashburton, to Roebourne.

Both these expeditions traversed the Western Pilbarra Goldfield. The de Grey Goldfield of Eastern Pilbarra was first explored by Frank Gregory in 1861; he then discovered the de Grey and Oakover Rivers, and the Throssell Range on the eastern boundary of the goldfield.

Little more was done in this district until 1895, when J. H. Rowe explored the heads of the Gascoyne and Ashburton Rivers; and then, working southward from the Pilbarra Goldfield, he discovered the Ophthalmia Range. The geology of this goldfield has been explored by A. G. Maitland, who issued a valuable preliminary report in 1904.

The East Pilbarra Goldfield and the country to the east of it was explored in 1897 by Rudall and F. H. Hann. Rudall had been sent out in 1897 to search for the missing members of the Calvert Expedition; and though he did not find them, he explored the great tract of country between Separation Well and the Throssell

and Gregory Ranges, on the eastern side of the Upper Oakover River.

Hann's expedition, which did further work in the same district, was one of the most important in Australia during recent years. He started from the Gulf of Carpentaria, and crossed the Kimberley division, past Hall's Creek, whence he attempted to cross the deserts to the head of the Oakover River; but he was forced to follow the Fitzroy River to the coast, and thus westward to Roebourne. Thence he struck up the Fortescue River, and crossed the country to the Oakover River; he conducted extensive explorations in the eastern part of the de Grey Goldfield, and some of the country to the east of it.

The Kimberley division long offered serious obstacles to exploration. A. C. Gregory, during his great North Australian expedition of 1856, crossed the goldfield through Hall's Creek and the Denison Downs to Sturt Creek, and along it to "Gregory's Salt Sea."

The great pastoral value of the country was first discovered by Alexander Forrest in 1879. Sir John Forrest followed in 1883; in this expedition he was accompanied by E. T. Hardman, the geologist, whose report directed attention to the probably auriferous nature of this country, and led to the discovery of the first payable gold in Westralia by Hall, near Hall's Creek, the present capital of the Kimberley division.

Hann, after his expedition of 1896-98, reported the occurrence of good pastoral country, and his report led to the dispatch, in 1901, of a Government expedition under F. S. Brockman, who was accompanied by A. Gibb Maitland, the Government geologist. It started inland at Wyndham and discovered some millions of acres of rich pastoral country, easily accessible from the coast.

The discovery of the overland routes from the Kimberley district to the central goldfields is due to the Calvert expedition of 1896, and Carnegie's expedition of 1896-97.

The Calvert expedition started from Lake Way in the East Murchison Goldfield, and explored the country between it and the Fitzroy River of the Kimberley division. Most of the route was near the meridian of 124° E. The southern part of the journey lay across fairly good country, but the latter part was waterless, and bore very little food. At Separation Well the party divided; the leader, L. A. Wells, kept due northward to Joanna Spring. C. F. Wells and G. L. Jones made a deviation to the westward; they picked up the tracks of the main expedition to the south of Joanna Spring; but they had been greatly delayed owing to the heavy nature of the country they had traversed, and they both perished, owing to the failure of their water supply, before reaching Joanna Spring.

The expedition of the late D. W. Carnegie started from the East Murchison Goldfield near Lake Darlôt, marched north-eastward to the Alexander Spring at the Sutherland Range, and thence crossed the northern deserts to Hall's Creek in the Kimberley division; he returned by a route further to the east, which was parallel to the South Australian border, as far as a little south of the Bonthyon Range; thence he struck south-westward past the Rawlinson Range and Lake Christopher to the Alexander Spring.

The literature of Australian travel is voluminous. The early coastal explorations are summarised in Collingwood's *The Discovery of Australia*, and the record is continued up to the date of 1800 by Flinders in his *Voyage to Terra Australis*.

The most convenient bibliographies are the Catalogue of Australian

Books in the Sydney Public Library, the Catalogue of Printed Books in the British Museum, the second edition of the York Gate Catalogue, and Dr. Mill's Catalogue of the Library of the Royal Geographical Society.

The best general summary of the inland work up to 1864 is in J. E. T. Woods' *A History of the Discovery and Exploration of Australia*, 1865, 2 vols.

A detailed summary up to 1888 is given by Favenc. *The History of Australian Exploration from* 1788 *to* 1888. 1888.

An excellent synopsis of work in Western Australia is given by M. A. C. Fraser, *Western Australian Year-Book for* 1902-1904, pp. 64-94.

Of special works, Eyre's journey is described in his *Journeys of Expeditions of Discovery into Central Australia*, 1840-41, 2 vols. 1845.

Captain Charles Sturt, *Two Expeditions into the Interior of Southern Australia during* 1828-31, 2 vols. 1834.

Mitchell's journeys, with his valuable scientific results, are given in *Three Expeditions into the Interior of Eastern Australia*, 2 vols. 1839.

Hume and Hovell's narratives are given in a *Brief Statement of Facts in connection with an Overland Expedition from Lake George to Port Phillip in* 1824, Sydney, 1855, and replies thereto. Hume and Hovell's diary is reprinted, as "Journal of Discovery of Port Phillip, N.S.W., in 1824 and 1825," *Trans. R. Geogr. Soc. Australasia* (*Victoria*), xi. (1894) pp. 65-119.

The scanty technical accounts of A. C. Gregory's expeditions have been collected in *Journal of the North-Western Australian Exploring Expedition, April to November* 1861. 1862.

A summary of the work in the Lake Eyre country, with full references to its scattered literature, appears in *The Dead Heart of Australia*, by the author.

The account of the Burke and Wills expedition is best given in Jackson's *Robert O'Hara Burke and the Australian Exploring Expedition of* 1860. 1862.

The relief expeditions, with their valuable geographical contributions, appear in *Tracks of M'Kinlay and Party across Australia*, by John Davis, edited by Westgarth, 1863; and reports by M'Kinlay and Landsborough.

The early exploration of Queensland is best given in *The Genesis of Queensland; an Account of the first Exploring Journeys to and over Darling Downs; the earliest days of their occupation; a Resumé of the Causes which led to Separation from New South Wales.* 1888.

Among the most important books on Westralian exploration are those written by John Forrest, Alexander Forrest, and D. W. Carnegie.

The best account of the Macdonnell Ranges is given in the narrative of the Horn Expedition by Professor Spencer.

J. M'Douall Stuart's journals are reprinted in "*Journals of Explora-*

tions in Australia, 1858-62, when he fixed the centre of the continent, and successfully crossed it from sea to sea." Edited by W. Hardman. 1864.

Calvert, Albert F. *The Exploration of Australia from* 1844 *to* 1896. 1896, pp. xiv and 386. Maps.

As a popular summary, see Thynne. *The Story of Australian Exploration.* London, 1894, pp. vi and 277; also the excellent sketch by A. W. Jose, *Australasia, the Commonwealth and New Zealand.* London, pp. 172. 1901.

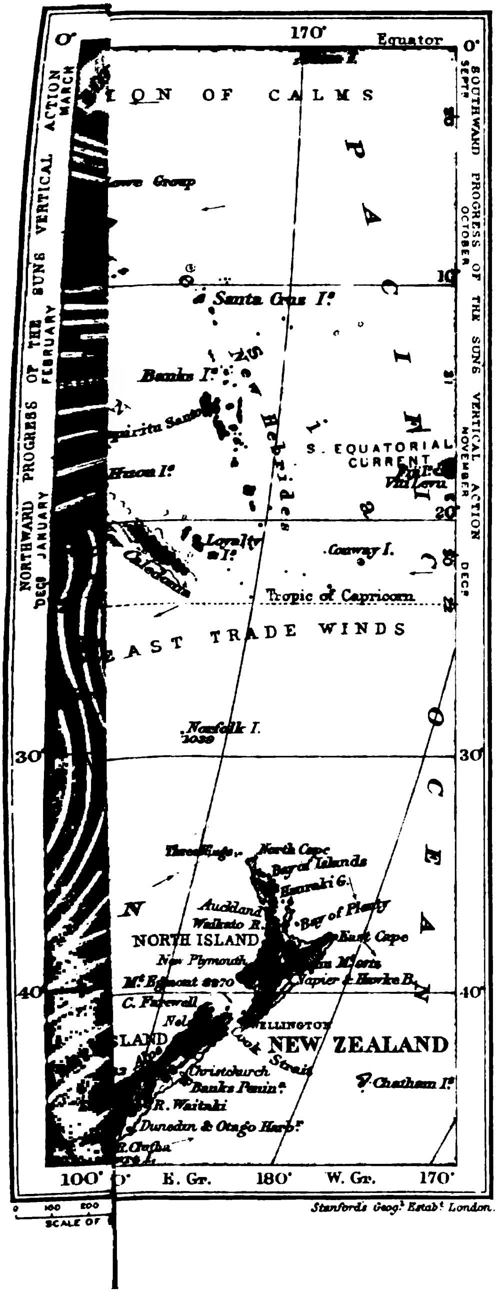
CHAPTER IV

THE GEOGRAPHICAL STRUCTURE AND RESOURCES OF AUSTRALIA

THE mainland of Australia extends from the latitude of 10° 39′ S. to 39° 11½′ S., and from the longitude of 113° 5′ E. to 153° 16′ E. Its width from East to West is approximately 2400 miles; and it is about 1970 miles across from North to South. The area, including Tasmania, is estimated at 2,927,906 square miles. Australia is bounded to the North by the Indian Ocean, the Arafura Sea, and Torres Strait; to the West by the Indian Ocean; to the South by the Southern Ocean; the southern part of its eastern shores is washed by the Tasman Sea, and the northern by the Coral Sea, one of the partially enclosed seas off the South Pacific.

Australia is divided into six States:—Queensland, New South Wales, Victoria, Westralia, South Australia, and Tasmania. The northern part of South Australia is separated as the Northern Territory. These political divisions are separated by well-marked natural boundaries, so that it is most convenient to describe the geography of each State separately; but a brief summary of the structure of the continent as a whole is advisable.

Australia stands on the southern part of one of the three meridional land masses which project from the



Stanford's Geog.l Estab.t London.

continental girdle of the northern hemisphere into the ocean girdle of the southern hemisphere. Australia is connected with Asia by the islands of Malaysia; and though that archipelago is traversed by one deep channel, it is too narrow to break the fundamental geographical connection between Australia and south-eastern Asia.

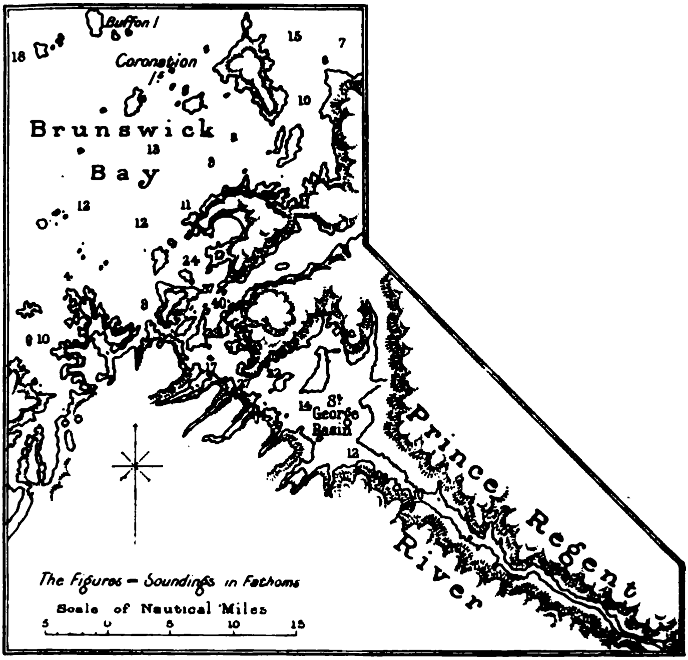
1. The Coasts

The Australian coasts are about 7750 miles in length, and are of two well-marked types. The whole of the northern, western, and southern coasts of the continent are, to use Professor Suess' term, of the "Atlantic type." The eastern coast of Queensland and New South Wales, and apparently the eastern coast of Tasmania, are a variety of the Pacific type.

The coasts of the Atlantic type include long lines of bare sand dunes, such as the Ninety Mile Beach in Victoria, and that of the same name in South Australia; the limestone bluffs along the Great Bight; the irregular, deeply-indented Red Coast of Tasman Land in the north-west; and high, rocky coasts, such as Point Jervis or Point Schank, which sink sheer into the sea.

The course of the coasts of the Atlantic type has no intimate connection with the geological structure of the adjacent lands. The strike of the rocks is often at right angles to the coast. The course of these Atlantic coasts has been determined by great subsidences, which have formed the ocean basins around Australia, instead of by movements parallel to the shore, as in Pacific coasts. The inlets on the coasts of the Atlantic type are due in the main to denudation; and some of those on the north-western coast, such as the Prince Regent River, have the characters of fiords. But the great arm of the

sea on the southern coast, Spencer Gulf, has been formed by subsidence along two lines of faults, being in fact a rift valley.[1] The eastern coast of Australia is of the



A FIORD ON THE NORTH-WESTERN COAST OF AUSTRALIA.

Pacific type, in which the mountains and the trend of the

[1] The term "rift valley," which was proposed in *The Great Rift Valley* (1896, pp. 5, 219) in connection with the valley of the Red Sea and the Great Rift Valley of East Africa, has been objected to by various critics; but the term has come into wide geographical use, and has been adopted as the name of one important political division in British East Africa. The term "trough valley," suggested in an article in the *Standard*, had been considered as an alternative, but was rejected on the grounds that it was less euphonious, and therefore less likely to be popularly accepted,

rocks are parallel to the shore, while the coast is skirted by an island festoon, consisting of New Guinea, New Caledonia, Lord Howe Island, and New Zealand. It is known as the Australasian Festoon. The eastern coast of Australia is, however, a less normal representative of the Pacific type than is the western coast of America. The typical Pacific structure is shown in the fragments of the Australasian Festoon. The eastern coast of the mainland is, however, entitled to inclusion in the Pacific group, as, with some local exceptions, the trend of the rocks, the course of the eastern scarp of the Highlands, the main coast line and the Great Barrier Reef are all approximately parallel. The Great Barrier Reef, the most famous feature of the Queensland coast, appears to consist of a thin cap of coral rock, covering a series of shoals, which marks the former extension of the land. The shoals continue southward beyond the limit of abundant coral growth, so that the coral limestones are probably only a layer of limestone over banks of other rocks. The ship-channels through the shoals and reefs may, as suggested by Andrews, mark the position of the old river channels.[1] In New South Wales the characters of the coast land are due, as shown by David, to a great monoclinal fold.

The eastern coasts of Australasia are of the Pacific type; but the eastern coast of the mainland represents

and less explanatory, as all valleys are troughs. Another recommendation of the term "rift" is that it indicates the resemblance between these valleys and the lunar rifts. The use of the term "rift" has been objected to on the ground that the valley has not been formed by two sides of a fissure being torn apart; but the English use of the term "rift" allows its application to a narrow cavity formed between two series of fractures, as for a breach in a wall (Bacon).

[1] An excellent description of the Queensland coast is given by E. C. Andrews, *Proc. Linn. Soc. N.S. Wales*, 1902, pp. 146-185.

that variety of the Pacific type due to subsidences behind the continental margin, having produced inland seas, which reach the plateaus behind the folded coasts. The subsidence of the former land mass that once filled up the Coral Sea and Tasman Sea gave the eastern rivers of Australia great powers of attack upon the land. Along the coast there are many islands formed of hard masses of rock, remnants of the former land, which have been left standing out at sea, while the softer rocks have been swept away.

The coast line, as a rule, consists of a wide coastal plain, which is generally a low flat composed of recent material that has been washed down from the Highlands by rivers. The coastal plain may be twenty miles wide, as it is near Brisbane; and it is also wide near Maryborough, at the mouth of the Burdett River, and near Mackay. The coastal plain is almost continuous along the whole eastern coast of Australia, and, as a rule, it ends off at the foot of the steep eastern face of the Highlands; but in places, as between Mackay and Cairns, the coastal plain is absent, and the highland country reaches the shore. The coastal plain is usually attributed to a recent elevation, of which there are similar traces in the Fiji, New Caledonia, and other off-lying islands; but there may have been a slight local lowering of the sea level, due to a subsidence of the sea floor.

2. The Interior Plateau

Australia is in the main a plateau land. Journeying inland from nearly every place on the coast there is a steep ascent to the interior. As the railway engineers found to their cost, all the railways have to begin a steep

ascent within a few miles of the coast.[1] Thus the railway in Queensland, which goes from the coast at Townsville across the Highlands to the Western Plains, rises rapidly from 248 feet to 994 feet between the 54th and the 59th miles from Townsville; it then undulates across the Highlands, reaching its highest point at Torrens Creek, 1528 feet, at 180 miles; whence it descends to Winton, at the height of 614 feet above sea level and 368 miles from Townsville. The Queensland "Central Line" starts at the sea level at Rockhampton, reaches its highest point, 1455 feet, at Drummond, 241 miles inland, and then descends to 612 feet at Longreach, 427 miles from Rockhampton.

The Australian plateaus appear fairly level over wide areas, when seen in broad distant views; and the highest summit in Australia, Mount Kosciusko, is only a blunt hummock on the surface of a high plateau. When we travel over the plateau country, however, we find that it is intersected by deep gorges, which have been cut through it by rivers. The old complex of mountain "ranges," which hindered the pioneers, and appear in abundant confusion on the maps of Australia, are only the ridges left by the wearing away of plateaus.

The main highlands of Victoria have been proved to be a great dissected peneplane; and Andrews has shown the same for the New England Tableland of New South Wales. The best known mountains seen from the coast are only the scarps of the inland plateaus. For example, the Blue Mountains west of Sydney have been formed by a monoclinal fold, as has been shown by Professor David. The Bass Range in Victoria is only the southern face of the highlands formed of the Jurassic

[1] The effect of the plateau structure of Australia on railway development has been clearly pointed out by Professor W. C. Kernot, "Australian Railways," International Engineering Congress, Glasgow, 1901.

Coal Measures. The Stirling Range in the south-west of Westralia, and the Darling Range behind the western coast behind Perth, are both the faces of the great Western Plateau; and, as A. C. Gregory noted in 1855,

Photo. *A. E. Kitson.*

SUMMIT OF MOUNT KOSCIUSKO, LOOKING SOUTH-EASTWARD.

The rocks are Gneissose-granite.

the Macadam Range of the Northern Territory is only the jagged edge of an inland plateau. In the interior the plateau has been worn by the winds, while the rainfall has been inadequate to carry away the waste material, or to cut out deep gorges. The plateau of Western Australia owes its surface features to denudation by rain, the long, slow decay by the atmosphere, and the distribution of loose material by the wind.

THE AUSTRALIAN ALPS, LOOKING NORTHWARD FROM THE SUMMIT OF MOUNT KOSCIUSKO. J. L. Kilson.

To the east of the great Western Plateau is the central basin of the continent, which has been formed by subsidence. Many of the basins of the continent, which have been attributed to denudation or, like some of the lake-basins of western Victoria, to volcanic craters, have been formed by the foundering of blocks of the earth's crust.

The general structure of Australia has been determined by the occurrence of two vast blocks of Archean rocks, which have remained since a very early period in the earth's history. The larger of these two blocks forms the great Western Plateau. Central Australia, from the Kimberley district in the north-west of the continent, to Victoria and Tasmania in the south-east, was once crossed by a long line of fold-mountains. The course of these fold-mountains was determined by the resistance of the Archean block of Western Australia, against the eastern edge of which these folded rocks were pressed. In north-eastern Australia, especially north-eastern Queensland, are the remains of a smaller but still extensive block of Archean rocks, which must once have extended far eastward into the Southern Pacific. Central Australia at one time was traversed by a high mountain chain of altered and contorted rocks, lying between the uncontorted plateaus of Western Australia and Eastern Australia. Since Middle Palæozoic times the old mountain area has been continuously worn down. No great earth-folds have since disturbed the structure of the Australian mass, and all the later earth-movements on the continent appear to have been the vertical sinkings of wide earth blocks.

3. The Geographical Subdivisions

Australia as a continent owes its mountain structures to Middle Palæozoic folding, broken up by Cainozoic faulting. This fact gives the best basis for the classification of the Australian mountains and geographical divisions.

THE MAIN GEOGRAPHICAL DIVISIONS OF AUSTRALIA.

The continent may be divided into three main parts: (1) the East-Australian Highlands, (2) the Great Plains that extend across East Central Australia, and (3) the great Western Plateau.

The East-Australian Highlands extend from Cape York across eastern Queensland and eastern New South Wales, and occupy eastern Victoria and the whole of Tasmania. They have been called the Australian Cordillera, but this term does not appear suitable, because this mountain

area is essentially different in structure from the Cordillera of South America. It has also been described as the Great Dividing Range, a name introduced as a legal term for the Victorian watershed. It was intended for a mathematical line, and not for an area; and this watershed or divide does not cross the highest summits, and often occurs in comparative lowlands. The Highlands cannot be satisfactorily described as a mountain "range," in the sense in which that term is generally used in geography. The mountainous country, being the worn-down base of an old mountain region, may be more correctly described as an area of "highlands." In Victoria such highlands occupy the whole of the eastern part of the State; and they taper westward between the north-western Mallee Plains and the rich, turf-clad western plains in the Great Valley of Victoria. That the present surface configuration of that State was not determined by the former mountains is shown by the complete independence between the strike of their rocks and the present levels of the country.

The Highlands of New South Wales occur in two main areas. The great Southern Plateau is continuous with that of eastern Victoria; it extends northward across the Monaro Plains to the highlands around Goulburn; and it includes the famous Blue Mountains, west of Sydney, of which the structure, originally described by Darwin, has been so well interpreted by Professor David. Then, further to the north, the old rocks disappear beneath the Coal Measures of the Hunter Valley. The Highlands reappear to the north in the New England Tableland, which is continued into Queensland; and they extend all across that State to the York Peninsula.

The Eastern Highlands generally have a steep

eastern face; but they slope more gradually westward, and pass into the wide plains which extend from the Gulf of Carpentaria to the basin of the Murray. The Gulf of Carpentaria is only a flooded part of these plains. The Gulf is continued southward by the valleys of the Flinders and the Leichhardt; their basin is separated by a flat divide from the basin of Lake Eyre. South of the Divide between Cloncurry and Hughenden is a great area of internal drainage; the largest part of it is drained by rivers which flow, when they flow at all, into Lake Eyre. The chief rivers are the Diamantina, Cooper's Creek, and the Macumba. There are some smaller areas of internal drainage, such as the Finke River to the north-west of Lake Eyre, and the basins of the Paroo and the Bulloo, between Cooper's Creek and the Darling. The basins of internal drainage, according to Bludau,[1] occupy an area of 1,567,500 square miles out of the 2,935,000, which he assigns to the Australian Continent. The area of these regions he allots as follows:—

1. Paroo and Bulloo River	61,800
2. Lake Eyre Basin	417,000
3. The Basin of Lakes Torrens and Gairdner .	39,400
4. Lake Frome Basin	46,300
5. Wimmera	34,000
6. Remainder of South and West Australia and Alexandra Land	969,000
	1,567,500

The lowest part of the lowland country in east-central Australia is occupied by Lake Eyre, the shore of which is 39 feet below sea level. To the south-east of this region of internal drainage is the basin drained

[1] A. Bludau, "Die Areale der aussereuropäischen Stromgebiete." *Pet. Mitth.* vol. xliv., 1898, p. 111.

Photo. *H. J. Grayson.*

THE DRY BED OF THE DIAMANTINA RIVER, NEAR LAKE EYRE.

by the Murray and its three chief components, the Darling, the Murrumbidgee, and the Upper Murray or Hume. The Murray, according to Bludau, has a basin of 351,500 square miles. The basin has a long slope from the plains of southern Queensland, across western New South Wales and western Victoria, to the Southern Ocean in South Australia. The Murray is the one great river of Australia, and is described in a special chapter, pp. 248-266.

To the south of the great depression of Lake Eyre are the Highlands of South Australia. They consist of a wide area of highlands, extending from the Great Valley of Australia eastward to the Murray. These Highlands form the rich wheat-growing country between Lake Torrens and Spencer Gulf on the west, and the Darling and Murray on the east. They include the Mount Lofty Range to the east of Adelaide, and extend northward to the Hergott Ranges, from the Willouran Range on the west to Mount Babbage on the east. Thence one arm of these Highlands extends north-westward, through the Stuart, Kingston, and Denison Ranges, along the eastern edge of the great Western Plateau of Australia. Another arm goes north-eastward along the line of the Stanley, Barrier, and Grey Ranges, till it sinks below the plains of Cooper's Creek.

The Highlands of South Australia are bounded to the west by the Great Valley of South Australia, which is occupied in the south by Spencer Gulf, and in the north by Lake Torrens. It is a rift valley. That the earth-movements which have caused it are of recent date, is indicated by the numerous earthquakes which still happen near Beltana, by the sharpness of the eastern scarp of the Flinders Range, and by the "Buldag," the "Desert-Sound," heard along this line.

The Highlands of South Australia pass westward, through the Hergott Ranges, into the great plateau of Western Australia, which occupies nearly all the continent west of the Overland Telegraph line. It is indented on the south by an extension northward from the Great Bight, which forms the artesian basin of Eucla. This basin rises by an ascent, of which the nature is imperfectly known, to the Western Plateau. On this plateau lies the shallow basin of Lake Amadeus, between the Musgrave Chain to the south and the Macdonnell Chain to the north. The mountains of the Macdonnell Chain are formed of Lower Palæozoic rocks, which are a continuation of those of South Australia, and extend still further north-westward into the Kimberley Goldfield of northern Westralia. The old mountains there lie upon the Western Plateau, which extends beyond them into Arnhem Land (4000 feet high), the northern peninsula between Cambridge Gulf and the Gulf of Carpentaria. Nearly the whole of the great Western Plateau is composed of Archean rocks, with the addition of some Lower Palæozoic in the Kimberley Goldfields; it is flanked by Upper Palæozoic and Jurassic and Lower Cainozoic rocks on the western and northern border of Westralia. The old Archean rocks extend to the Darling Range, which is the western scarp of the plateau behind Perth, and to the Stirling Range, which is the southern scarp of the plateau, at the south-western corner of the continent, behind Albany.

The Western Plateau has upon its surface numerous shallow lake basins, such as Lakes Austen, Way, Lefroy, and Carey, which are either dry or contain pools of concentrated brine.

4. River System

The river system of Australia depends on the distribution of its highlands and mountains. The rivers are most numerous down the eastern slope of the Eastern Highlands. The rivers there are many, but as a rule their course is short. They carry the abundant rainfall to the eastern coast. Some of these rivers have a simple direct course to the sea; such are the Hunter, Burnett, the Manning, and the Tweed. Others are of a "Y" shape or "T" shape, consisting of a lower short arm, running eastward near the sea, and two upper branches running parallel to the coast along subsequent valleys. Such are the Fitzroy River, formed by the union of the Mackenzie and the Dawson; the Burdekin River, formed by the union of the Burdekin from the north and the Belyando from the south; the Clarence River, formed by the junction of the Clarence and the Mitchell; and the Hawkesbury River, formed by a long southern branch, which runs parallel to the coast until its confluence with the Colo from the west and the Macdonald from the north; from this point the river turns eastward and runs directly to the sea at Broken Bay. The southern rivers of Victoria agree in their general characters with the eastern rivers of New South Wales. Such are the Snowy River, which meanders through deep valleys in the New South Wales Highlands, before it flows southward, across Eastern Victoria, to the sea; also the Tambo, the Yarra, and the Glenelg.

The second series of rivers in Australia are those which flow westward down the slope of the Eastern Highlands. Beginning in the north, there are the Mitchell and the Gilbert, which flow into the Gulf of Carpentaria. Then follow the Diamantina and the

Barcoo or Cooper's Creek, which enter Lake Eyre; and the Bulloo and the Paroo, which are lost in the plains to the west of the Darling. The greatest river of Australia, the Murray, drains the whole of the southern part of the Eastern Highlands; it is now a compound river, formed by the engrafting of three once independent rivers, the Darling, the Murrumbidgee, and the Hume, on to one trunk, the Lower Murray.

The Western Plateau of Australia is ill provided with rivers. In the north-west, where the rainfall is heavy, there are considerable rivers, such as the Daly, the Victoria, and the Fitzroy. The Pilbarra Goldfield and the adjacent regions are drained by a series of rivers, the Oakover, the Fortescue, and the Ashburton, all of which discharge on the north-western coast. On the northern part of the western coast there are the Gascoyne and the Murchison. To the south of the Murchison is the Greenough, and its much smaller size indicates the arid nature of the country behind it; thence southward, the whole of the western and southern coasts of Western Australia have no rivers of any particular size or importance.

5. The Flowing Wells of East Central Australia

Between the Western Plateau and the East Australian Highlands are the Great Plains of Central Australia. The northern part of them drains into the Gulf of Carpentaria; the southern part into the Southern Ocean, through the Darling and the Murray; and the western part is an area of internal drainage, forming the basin of Lake Eyre. Most of this country is arid, with no surface water, and its rich soils are accordingly wasted. But deep below the surface there are layers of sands and shales saturated

with water. This water is under such high pressure that when bores are sunk through the clays, which form the top of the underground reservoir, the water rushes up the bore-hole to the surface, and there discharges as a flowing well. The Mound Springs to the west and south-west of

Photo. *J. W. Gregory.*

ARTESIAN WELL AT KOPPERAMANNA, ON COOPER'S CREEK, EAST OF LAKE EYRE.

(Temperature of the water about 180°.)

Lake Eyre, and in the valley of the Flinders River, are natural outlets from this layer of compressed water; they occur where the water-logged rocks end against the Archean rocks of the Western Plateau. In 1880 some wells sunk by Suetonius Officer, at his station at Kallara, in the west of New South Wales, reached the underlying

water-bearing layer; he thus proved the possibility of watering the barren plains of Central Australia by deep wells. In 1882 Dr. R. L. Jack concluded, from the geological structure of Queensland, that a supply of artesian water might occur in the west of that State. In 1885, owing to the severity of the drought then afflicting western Queensland, Dr. Jack and Mr. J. B. Henderson, hydraulic engineer to the Queensland Government, were instructed to select a site for a trial bore. They chose Blackall, and a bore was completed there in 1888. A water-bearing layer was reached at a depth of 1645 feet, and from it the water rose to the surface and discharged 291,000 gallons a day.

This success led to the boring of wells in many parts of Central Australia, and the geological surveys of the different States have successfully defined the general limits of the area within which this deep well water may be found. Wells have been sunk in widely scattered localities over the central basin. By June 30, 1904, 973 wells had been sunk in Queensland, of which 596 are flowing wells, giving a total flow of 62,635,722 cubic feet a day. The deepest well is that of Whitewood, at Bimerah, 5046 feet deep. In New South Wales, by June 30, 1904, 119 Government bores had been completed; they have resulted in 80 flowing wells and 24 sub-artesian wells, with a total discharge of 54,000,000 gallons a day. There are also 144 successful private bores. The Government flowing wells discharged then 49,300,000 gallons a day.[1] In South Australia there are 38 deep bores, 20 of which give a total yield of 6,250,000 gallons a day; 2 are unfinished, and 16 have been unsuccessful.

[1] Coghlan, *Statistical Account of Australia and New Zealand*, 1903-4, p. 401.

Large though the supply of this deep water may be, the arid plains of Central Australia are so vast in extent that no considerable proportion of the country can be irrigated by it. Much of the water, moreover, is unsuitable for agricultural use, owing to its mineralised character. Some irrigation has been accomplished with artesian water, as at Pera in New South Wales, and at the Lake Harry date-plantation in South Australia. The main value of the water is to furnish a supply at intervals along tracks that would otherwise be waterless. Stock routes can thereby be kept open across the deserts from cattle-raising districts to the railways and markets. The wells are also useful for watering stock on stations, and for growing crops of lucerne for use as fodder during periods of scarcity. The deep well water is of such high value for these purposes that it has effected a great improvement in the economic conditions of the central plains of Australia.

The wells have been called artesian, and as that term, according to Professors Chamberlin and Salisbury, is now applied to any notable deep well, no objection need be taken to the name. The rise of the water in these Australian wells has been attributed to the hydrostatic pressure of the water occurring in the same layer of rock at a higher level in the Queensland Hills.

As is usually the case with artesian water, its origin has been attributed to remote localities, such as the Eastern Highlands of Australia, and even the mountains of New Guinea, the Himalaya, and the Andes.

It was suggested at first, from the geological structure of Central Australia, that the wells were supplied by the percolation of rain and river water through the beds of Blythsdale Braystone. This rock outcrops on the western slopes of the Eastern Highlands. It was thought to

extend in a continuous layer under the clays of the Rolling Downs Formation, which is the main foundation of the central plains. The well water was thought to be meteoric water, which had fallen on the Queensland hills, and was thence flowing westward as a subterranean river, and discharging to the Southern Ocean, through the Murray River, Spencer Gulf, or the Great Australian Bight. A bore through the Rolling Downs Formation was thought to tap a buried river flowing through the porous Blythsdale Braystone, whence the water rose in the wells, for the same reason as water rises in one arm of a U-shaped tube when poured into the other. But the Blythsdale Braystone has proved to be a limited formation, and quite unable to supply all the wells that have been sunk. Many of them derive their water from the shales and mudstones of the Jurassic beds.

A general account of the flowing wells of Central Australia has recently been given by the author in the *Dead Heart of Australia* (1906, pp. 273-341); the author has there pointed out that the simple artesian theory does not explain the facts. The chemical characters of the well waters; their thermal phenomena; the irregular distribution of the water pressure; the association of the water with various gases—(the town of Roma, in Queensland, is at present lighted by gas which escapes from the local artesian well)—and the tidal rise and fall of the water in some of the wells, present a series of phenomena none of which agrees with the hydrostatic theory. The author maintains that the information now available regarding these flowing wells shows that the ascent of the water is mainly due to the tension of the included gases and the pressure of the overlying sheets of rock. Most of the water is an old accumulation, some of which may have been derived by percolation

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from meteoric sources; much of it is probably of plutonic origin, having risen through deep springs from the underlying rocks; and some of it may be old sea-water from the Cretaceous beds.

The point of practical importance involved in the correct explanation of the genesis of these wells is that, at present, a large proportion of the water is allowed to run to waste. Proposals at different times have been made to stop this waste by legislation; but the Bills proposed were rejected, on the ground that the wells are renewed by percolation at a rate compared with which the output of the wells is insignificant. According to a former Surveyor-General of Queensland, the fear of exhausting the artesian water-supply is as idle as the fear of affecting the volume of the ocean by drawing water from it. The author, however, believes that the existing waste of artesian water is deplorable, as the supply may prove to be not inexhaustible.

6. General Factors in the Economic Geography

The economic development of Australia depends upon its geographical relations, its climate, and geological structure. Geographically the continent, as a whole, is ancient; it is isolated; and when settlement began it was practically unoccupied, and had neither animals nor plants suitable to maintain a considerable or prosperous population. Its climate is dominated by the fact that the continent is elongated from east to west in the direction of the movement of the principal winds; and the conditions of oceanic circulation give Australia a heavy rainfall on the eastern coast and a comparatively light rainfall on the western coast. The striking contrast in the rainfall of the eastern and western coast is due to the different tempera-

tures of the adjacent oceans. The eastern coast is washed by a warm ocean current, which flows along the coast from the north. The winds which blow inland are heavy with moisture, which is precipitated as soon as the warm winds are chilled by contact with the high land.

On the coast of Western Australia there is a cold current going northwards from the Southern Ocean; so the winds that blow inland pass from cold water on to warm land; they are raised in temperature and are able to absorb moisture rather than to deposit it. Hence the hills of Eastern Australia are clad in dense forests, and the plains produce sugar, wheat, grains, grasses, and other valuable crops; but along the western coasts, with the exception of a small area in the south-western corner where the rain supports the forests of jarrah timber, the country consists of open moors, which have a rich soil but an inadequate water-supply. The prevalent winds sweep across the whole width of the country from west to east, but they have lost most of their moisture before they reach the interior, which therefore has an arid desert climate.

The climatic conditions of Australia therefore directly determine its economic value, giving the continent its tropical north, its fertile east and south-east, its arid west, and its almost empty interior. The low eastern plains, with their rich soils but light rainfall, support the vast flocks of sheep, of which Australia in 1891 had 124,991,920, and even after the heavy loss of 1901 and 1902 contained, in 1903, 73,652,026.

Pastoral Industry.—The wool of Australia has been its staple and most reliable product. The pastoral industry of Australia was founded by Captain John M'Arthur, one of the officials connected with the Convict Station at Port Jackson. He was greatly impressed with the suitability of the climate of New South Wales for the

growth of fine wool sheep. He endeavoured to get a flock of merinos from Spain, but their export was then a capital offence. So he had to be content with some half-bred merinos from the Cape. According to his own statement[1] of the 26th July 1803, he first obtained three Spanish rams and five ewes from the Cape of Good Hope in 1797. They were the progeny of Spanish sheep sent from Holland to the Cape of Good Hope. M'Arthur's small flock rapidly multiplied, and he mixed his previous ewes with Spanish rams. He thus effected a great improvement in both the weight and the quality of the wool. The growth of his flocks was rapid: in 1796 the total stock of the colony was 1531; in 1801 it had increased to 6767. At length M'Arthur was able to secure a still further improvement by breeding from a pair of pure Spanish merinos. During the Peninsular war the King of Spain presented George III. with a small flock of picked Spanish sheep. The enterprising M'Arthur managed to get a ram and a ewe from the royal stud at Windsor. He took them back with him to Australia. This pair of merinos, with those previously obtained from the Cape, are the ancestors of the existing Australian flocks.

The export of the wool appears to have begun in the year 1807, and its growth is shown in the following table:—

Year.	Wool Lbs.	
1807	245	
1815	32,971	
1821	175,433	
1831	1,401,284	
1835	3,776,191	
1903	399,886,321	excluding the 177,575,197 lbs. produced in New Zealand.

[1] In *James Macarthur, New South Wales.* London, 1837. Appendix No. 31, pp. 177-180.

State.	Number of Sheep.					Number of Cattle.		
	1871.	1881.	1891.	1901.	1903.	1881.	1891.	1903.
New South Wales	16,278,697	36,591,946	61,831,416	41,857,099	28,656,501	2,597,348	2,046,347	1,880,578
Victoria . . .	10,002,381	10,267,265	12,928,148	10,841,790	[1] 8,744,731	1,286,677	1,812,104	[1] 1,522,265
Queensland . .	7,403,334	8,292,883	20,289,633	10,030,971	8,392,044	3,618,513	6,192,759	2,481,717
South Australia .	4,412,055	6,810,856	7,745,541	5,060,540	5,350,258	314,918	676,933	536,580
Western Australia	670,999	1,267,912	1,962,212	2,542,844	2,600,633	63,009	133,690	497,617
Tasmania . . .	1,305,489	1,847,479	1,664,218	1,792,481	1,597,053	130,526	167,666	185,938
Commonwealth	40,072,955	65,078,341	106,421,168	72,125,725	55,371,220	8,010,991	11,029,499	7,104,695
New Zealand . .	9,700,629	12,985,085	18,570,752	20,233,099	18,280,806	698,637	831,831	1,593,547
Australasia . .	49,773,584	78,063,426	124,991,920	92,358,824	73,652,026	8,709,628	11,861,330	8,698,242

1 Estimate.

The table on the preceding page shows the number of sheep and cattle in each State in recent decades.[1]

Mineral Resources.—The mining-fields depend on the geological structure of the country. The coalfields of Australia are mainly along the eastern coast, to the north of Sydney; and there we may expect the development of the chief manufacturing metropolis of Australia. Gold-mining is mainly in the Archean and Lower Palæozoic rocks, or in later alluvial deposits derived from them. The goldfields occur scattered over the highlands of Queensland, New South Wales, and Victoria, which, though the smallest State in Australia, has yielded over £250,000,000 of gold. The scattered mining-fields of the interior of Australia are on Archean rocks.

The value of the current mineral products is shown by the following table for the year 1903:—

[1] T. A. Coghlan, *Statistical Account of Australia and New Zealand*, 1903-4, pp. 410, 415.

[TABLE

Description of Mineral.		Western Australia. Quantity.	Western Australia. Value.	New South Wales. Quantity.	New South Wales. Value.
			£		£
Gold	Fine ounces	2,064,801	8,770,719	254,157	1,080,02
Copper	Statute tons	..	..	5,631	431,18
Copper ore	do.	20,126	56,541	3,570	
Lead	do.	..	..	3,505	38,58
Manganese	do.	..	..	74	25
Platinum	Fine ounces	..	..	530	1,06
Silver	do.	168,113	19,153	1,099,873	
Silver ore	Statute tons	..	..	330,581	1,501,40
Silver-lead ore	do.	..	..	18,483	
Tin	do.	..	..	752	
Black tin	do.	817	55,890	..	124,89
Tin ore	do.	..	..	547	
Wolfram	do.	..	..	..	..
Zinc spelter	do.	..	..	20,754	86,58
Antimony	do.	22	230	13	13
Bismuth	do.	..	..	22	9,53
Alunite	do.	..	..	2,485	6,21
Coal	do.	133,427	69,128	6,354,846	2,319,66
Brown coal	do.	..	..	..	..
Coke	do.	..	..	160,592	108,76
Shale (oil)	do.	..	..	34,776	28,61
Cobalt ore	do.	..	..	153	1,57
Gypsum	do.	..	..	..	..
Iron	do.	..	..	6,086	85,79
Iron oxide	do.	..	..	1,194	1,19
Ironstone	do.	220	88	22,120	15,39
Lime	do.	..	..	23,579	17,21
Limestone	do.	1,280	178	23,824	14,2
Molybdenite	do.	..	..	29	4,45
Plumbago ore	do.	..	..	..	..
Precious stones	Carats	..	..	..	[5] 109,9
Unenumerated		..	10	..	72,3
Total values		..	£8,971,937	..	£6,059,4

[1] Including Northern Territory. [2] Includes blister copper, 6684 tons, valued at £569,304.
[5] Diamonds, 12,289 carats, valued at £9987, and opal valued at £100,000.

FOR THE YEAR 1903.

Queensland.		Tasmania.		South Australia.[1]		New Zealand.		Victoria.	
Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value
	£		£		£		£		£
668,546	2,839,813	59,892	254,408	21,195	90,081	479,746	2,087,832	767,847	3,259,483
4,916	285,122	[2] 10,411	652,928	6,490	417,087	..	..	..	..
..	..	102	790	7,069	54,922	6	123	25	500
3,796	43,639	..	..	720	8,799	[3] 21	170	..	..
1,320	5,332	..	..	10	19	70	210	..	..
..	..	..	..	..	..	..	..	..	..
642,125	65,538	..	..	7,086	804	911,914	91,497	28,800	2,880
..	..	..	..	..	..	..	..	..	..
..	..	4,242	192,492	211	1,267	..	..	..	..
3,709	243,149	2,376	300,098	..	..	..	..	..	..
..	..	..	..	..	..	..	..	33	2,165
..	..	306	10,822	..	..	2	180	..	..
197	7,870	..	..	..	..	..	..	..	..
..	..	1,247	3,092	..	..	..	..	..	..
..	..	..	..	..	..	..	..	5	50
11	2,523	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..
507,801	164,796	49,069	41,709	..	..	1,418,294	909,147	64,200	40,818
..	..	..	..	..	..	..	..	5,661	2,827
..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	8,590	897
..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..
9,806	3,852	5,980	2,905	..	..	..	..	..	..
13,612	8,060	..	..	..	..	24	92	..	..
..	..	..	..	..	..	..	..	..	..
[4] 24	2,100	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..
..	[6] 14,300	..	..	..	..	..	..	..	..
..	..	..	7,475	..	81	..	2,215	..	16,900
..	£3,686,006	..	£1,460,714	..	£572,960	..	£3,041,466	..	£3,326,520

[3] Lead ore. [4] Includes some bismuth and wolfram.
[6] Includes opal valued at £7300.

Photo. *W. Dewey.*

GOLDEN POINT, BALLARAT.

The site of the earliest discovery of first-rate mining importance in Australia. The gold occurs in gravel lying on Lower Palæozoic slates.

Manufactures.—The manufacturing industry has been naturally the last to develop, but during recent years it has made substantial progress. The number and distribution of the factories and the nature of the industries are shown for the year 1903 in the two following tables:[1]—

State.	Establishments.	Hands employed.		
		Males.	Females.	Total.
Victoria . . .	4,151	49,434	23,795	73,229
N.S. Wales . .	3,476	52,453	13,180	65,633
Queensland . .	2,001	16,139	3,147	19,286
South Australia . .	1,339	14,703	3,941	18,644
Western Australia .	586	10,494	1,389	11,883
Tasmania . . .	426	6,442	1,307	7,749
Commonwealth .	11,979	149,665	46,759	196,424
New Zealand . .	3,960	41,022	11,606	52,628

Class of Industry.	Commonwealth.		New Zealand.		Australasia.	
	Males.	Females.	Males.	Females.	Males.	Females.
Clothing and textile fabrics and materials . . .	16,932	36,358	7687	9579	24,619	45,937
Metal works, machinery, etc.	36,285	91	6259	5	42,544	96
Connected with food and drink, etc. . . .	26,755	4,555	7069	628	33,824	5,183
Working in wood . .	16,232	30	6635	2	22,867	32
Books, paper, printing, and engraving . . .	13,756	3,477	2799	754	16,555	4,231
Vehicles and fittings, saddlery and harness, etc. .	7,457	69	2636	55	10,093	124
Processes in stone, clay, glass, etc. . . .	7,859	85	1273	2	9,132	87
Treating raw material, the product of pastoral pursuits	5,570	22	2286	1	7,856	23
Furniture, bedding, and upholstery . . .	5,012	428	1887	76	6,899	504
Heat, light, and power .	3,575	91	763	166	4,338	257

[1] Coghlan's *Statistical Account of Australia and New Zealand*, 1903-4, pp. 961 and 972.

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CHAPTER V

THE AUSTRALIAN FAUNA AND FLORA

EARLY Arab sailors brought back with them from their eastern voyages stories of large animals whose young crept for shelter into a pouch in the mother. Ever since the verification of this tale, by the discovery of living marsupials in Australia, that region has been regarded as the home of animals of exceptional interest. Later on it was found that the marsupials, now the dominant mammals of Australia, existed in Europe far earlier than trace of them has been found in Australia; and they only became extinct in Europe early in Cainozoic times. This discovery led to the belief that the Australian fauna was a survivor of the Mesozoic fauna of Europe and Asia, protected by isolation. This view intensified the interest in Australian biology, and it appeared to be strengthened when sharks of such ancient types as the Carcharodon were found in Port Jackson; and Trigonia, one of the most characteristic genera of European Mesozoic mollusca, was discovered still living in Australian seas.

The flora of Australia was regarded as equally conservative and primitive as the animals. "Basing their conclusions to some extent on zoological data, botanists have assumed that the Australian flora is of a lower and less specialised type than that of the northern hemi-

sphere and the tropical regions. It exists to-day, we are told, simply because it has remained isolated from the great land areas of the Old World, and but for this, an exotic flora would have overrun the island-continent."[1] Australia has, it is true, a considerable number of European genera; but these were regarded as plants which had forced their way into Australia, and were there spreading rapidly, owing to their superiority to the inferior native vegetation. Tate described the native plants of Central Australia as being now rapidly supplanted by immigrants from the northern hemisphere.

Hence Australia was regarded as indebted both for its plants and its animals to Eurasia. It was thought that they arrived at some very early period, and have since been protected by the seas of Malaysia from invasion by more specialised types, which developed later in the great land mass of the northern hemisphere.

This conception has affected the whole treatment of Australian biology; and it helped to increase the belief that the human inhabitants of Australia and Tasmania were the most primitive and archaic of existing races of mankind. This view was suggested in regard to the aborigines by their simple habits and the scanty equipment necessary to their nomadic life. During the last few years, however, the interest in the Australian fauna and flora has undergone a great change. Recent discoveries have shown that the old hypothesis cannot be fully maintained. It was believed that of the two orders of marsupials which are found in Australia, the Polyprotodonts were the most primitive, and arose from a Eurasian ancestor, whence also descended the living opossums of America. The special Australian order, the Diprotodonts,

[1] Spencer Moore, "Suggestions upon the Origin of the Australian Flora," *Nat. Sci.* xv. 1899, p. 198.

including the kangaroos and the wombats, were regarded as confined to Australia and as having developed there from some polyprotodont ancestor. This view, however, has been shattered by the discovery of two living species of diprotodonts (*Coenolestes*) in Ecuador and the United States of Colombia, and the discovery of a rich extinct diprotodont fauna in the Cainozoic deposits of Patagonia. Instead of the Tasmanian wolf (*Thylacinus*) being exclusively confined to South-eastern Australia and Tasmania, it had a near relative in Patagonia; and the jaws of the highly specialised diprotodont, Pyrotherium of Patagonia, has, as Dr. Andrews has pointed out to me, a striking resemblance to those of Diprotodon, the giant wombat of Eastern Australia. This wide distribution of the Diprotodonts in South America and Australia, and their complete absence (for such forms as Polymastodon are probably not marsupials at all) from Europe and Asia, suggests a former land connection between Australia and South America. Belief in this connection was increased by the occurrence of the land tortoise Miolania, in Lord Howe Island, and in Patagonia; and it was greatly stimulated by the fact that some fresh-water fish, such as the trout (*Galaxias*) of Australia and Tasmania, live in the rivers and lakes of Chili; even one species, *Galaxias attenuatus*, is identical on the rivers on the opposite sides of the Southern Pacific. The evidence of Galaxias, however, proves too much to be of any value. If a land connection between South America, New Zealand, and Australia must be accepted to explain the occurrence of Galaxias in all of them, then the land connection must have lasted till late Cainozoic times; for one species of Galaxias (*G. attenuatus*) occurs in the rivers flowing into opposite shores of the South Pacific. But Dr. Boulenger has pointed out that all the species of Galaxias breed in the sea; so that they give

no evidence whatever in favour of a land connection between South America and Australasia.

The land worms and slugs give more reliable evidence, for they are so easily destroyed by contact with salt water that their migrations seem necessarily confined to land; hence, when genera which are absent from the northern hemisphere are found on both sides of the Southern Pacific, it seems to imply transit along some southern land now destroyed. Benham has clearly explained the evidence afforded by the distribution of the land worms; and he shows that the worms of Western Australia show a marked affinity to those of Ceylon, in contrast with the striking differences between the worms of Australia and those of the islands of Malaysia and the south-eastern mainland of Asia. There is, moreover, no close connection between the earthworms of Australia and of New Zealand; but those of New Zealand show "a very close affinity to the southern extremity of Africa, on the one hand, and to South America on the other."

The accumulation of much fresh evidence has led to a complete change of view in regard to the relations of the animals and plants of Australasia. Spencer Moore has vigorously attacked the idea that the Australian flora is inferior to that of other lands; and instead of considering the fauna as an isolated colony which has survived from the Jurassic period of Europe and Asia, we have been taught to look for its origin in a great southern land, which connected Australasia and South America in late Mesozoic and, perhaps in part, in early Cainozoic times.

The long north-westward projection of the Patagonian plateau from South America, the long line of coral islands from Malaysia through the Paumotu Archipelago — "garlands laid by the hand of nature on the tomb of departed islands,"—and the increasing geological evidence

of the former existence of ancient plutonic and sedimentary rocks in that area, point to Hutton's South Pacific Continent as the probable position of the connecting lands.

1. The Animals of Australia

The most striking feature in the zoology of Australia is the fact that, with the exception of a few rats, mice, and bats, and the dingo, all the indigenous mammals belong to the two most primitive groups, the monotremes and marsupials. No representatives of the higher mammalia, with the insignificant exceptions already mentioned, are found in Australia or New Zealand; there are no indigenous monkeys, cattle, sheep, pigs, antelopes, deer, bears, elephants, cats, weasels, foxes, hares, or rabbits. This fact shows that Australia has been separated from the mainlands of the northern hemisphere throughout later Cainozoic times. Before Australia was separated it was occupied by the marsupials and the monotremes; and members of these two groups of mammals have adopted many of the different habits of life possible to land mammals. They have developed forms which in the northern hemisphere are found among animals of distinct orders. Thus the thylacine of Tasmania, as implied by its popular name of Tasmanian wolf, has the form and habit of a wolf. Many of the dasyures are so cat-like that they are known as native cats. The flying phalangers resemble the flying squirrels in form and habits. The echidna, a monotreme, has quills like the porcupine. The kangaroos have the gait of some Mesozoic reptiles; and some of the kangaroo rats have the jumping power of the African jerboa. The koala is called the native bear from its clumsy form, short bandy legs, and arboreal life. The names of the "kangaroo rats," "kangaroo rabbits," and the "marsupial badger" indicate the external

resemblance of these marsupials to European mammals of various orders. The great variety in the forms of the marsupials indicates their great antiquity on the Australian continent, and their long occupation of the land without competition from higher types of mammalia. The only other mammals which appear to have occupied Australia before the advent of man are a number of rats and mice, and a few bats and the dingo; and it is still open to doubt whether the dingo was not introduced by man.

The predominance of marsupials is the chief characteristic of the Australian zoological region, which is sharply marked off from Asia and the Asiatic islands by Wallace's Line. This line separates the islands of the Oriental regions, which belong zoologically to Asia, from the islands that belong zoologically to Australia. The line passes to the east of Bali and the west of Lombok. Thence, according to Wallace, it continued northward between Celebes and Borneo; but according to some later authorities, as, for example, W. Sclater (map, p. 166), Celebes belongs to the Oriental regions, and Wallace's Line should be diverted eastward across the Floris Sea, between Celebes to the north and the islands of Sumbawa and Floris, and thence northward off the eastern coast of Celebes. All the lands to the east of this line belong to the Australasian zoological region, which includes the islands of the Eastern and Central Pacific. The animal life on the two sides of Wallace's Line is remarkably different: Asiatic kinds predominate to the west of it, and Australasian to the east. Some overlap of the Oriental and Australasian animals occurs. Thus, the Papuan region (which includes New Guinea, the island of New Britain, the Solomon Islands, and all the islands between New Guinea and Wallace's Line) is inhabited by 50 species of mammals, of which 8 are confined to the

Papuan sub-region; 12 of them occur both in the Papuan and Australasian sub-regions; 29 occur in the Oriental, Papuan. and Australasian sub-regions.

The Australasian region is divided zoologically by Mr. W. Sclater into five sub-regions (map, p. 166): (1) The Australian, including the mainland of Australia, Tasmania, and Lord Howe Island; (2) the Maorian, comprising New Zealand, Norfolk Island, and the Kermadecs; (3) the Papuan sub-region, including New Guinea and the islands of Malaysia from Lombok on the west to the Solomon Islands on the east; (4) the Polynesian sub-region, including all the scattered islands of the Central Pacific, with New Caledonia, the Fiji, and the Caroline islands; (5) the Hawaiian sub-region, the Hawaiian Archipelago.

This classification is founded on the distribution of the mammalia, which is less satisfactory in this case than the evidence of the invertebrates, which are more abundant.

Australia has over 170 species of mammals, which belong to 60 genera, of which 30 genera are peculiar to it. Members of the remaining genera occur in New Guinea, the Western Islands of the Papuan sub-region, or in the Oriental region.

The mammals of Australia include representatives of each of the three primary divisions of the class of mammalia, viz. Prototheria or Monotremata, the Metatheria or Marsupialia, and the Eutheria, or higher mammalia.

2. Monotremes

The Monotremata are the most primitive of existing mammals. They include two chief genera, Ornithorhynchus, the famous duck-billed Platypus, and the Echidna or spiny ant-eater. The Platypus or "water-duck mole" lives beside the rivers and lagoons of

Eastern Australia as far north as 18° S. in Southern Queensland, and in Tasmania; it spends much of its time in the water, retiring to burrows in the banks to sleep and breed. It has small teeth, which were first discovered by Poulton (1888), and proved by Thomas (1889) to be functional in the young, but to be shed like the milk teeth of the higher mammals. It has a muzzle called the "duck-bill,"[1] and is said to lay eggs, of which, however, the evidence appears to be still inadequate. In many points its anatomy resembles that of the reptiles, to which it is the most closely allied of living mammals. It is such an abnormal animal that when the first stuffed specimen was sent to Europe it was declared to be a fraud, made up of a duck's bill attached to the skin of some animal.

THE DUCK-BILL PLATYPUS.

The Echidna or spiny ant-eater is more widely distributed than the Platypus. The common species ranges throughout the mainland of Australia; one variety of it is found in New Guinea, another in Tasmania. The animal is protected by spines, and when attacked, rolls itself into a ball like a hedgehog. It lives in dry soft ground, into which it burrows with remarkable rapidity. It is oviparous. A third genus of Monotremes, Proechidna, the three-toed ant-eater, is represented by two species (of which *P. bruijni* is the better known), which live in the mountains of Western and North-western New Guinea.

[1] The structure of the "bill" is described in detail by Wilson and Martin, Macleay Memorial volume, pp. 179-200, Pl. 22-26. The bill is not horny, but has a soft skin like that of a dog's nose.

3. Marsupials

The Marsupials are the characteristic mammals of Australia. Until recently this order was regarded as confined to Australia, with the exception of the Opossums in America. But discoveries in South America have shown that members of both the existing orders of Marsupials live on that continent.

The Marsupials differ from the higher mammals in the very primitive stage at which the young are born; they are dropped from the uterus before the development of the placenta, and are transferred by the parent to a pouch, where they hang by the mouth to long mammae, through which milk is forced by the mother into the stomach of the young. This non-placental condition of the marsupials is not an archaic survival; for Hill of Sydney has shown that the bandicoots (*Perameles*) have a rudimentary placenta. Moreover, only one or two of the teeth have milk teeth, which are shed before the growth of the adult teeth. These facts indicate that some of the characters in living marsupials, which once appeared most primitive, are due to degeneration from ancestors that were more nearly allied to the higher mammals.

The marsupials are divided into two orders, the Polyprotodontia, in which the incisor teeth are small and number either eight or ten in the upper jaw, and six or eight in the lower jaw; in the second order, the Diprotodontia, there are usually six incisors in the upper jaw, and a pair of large tusk-like incisors in the lower jaw; but there may be only two in the upper jaw, as in the wombats, and there may be six in the lower jaw, as in the striped opossum (*Dactylopsila trivirgata*) of Queensland and New Guinea.

The Polyprotodonts include three families. The first is that of the Peramelidae or the bandicoots, mostly small

A NATIVE CAT OR YARRI (*Dasyurus maculatus*).

ground-dwelling animals, which feed on worms, insects, and roots. The largest member of this family, the native rabbit (*Peragale lagotis*), lives in burrows in sand-hills in the Central Plains. The most remarkable member of this family is the Choeropus, in which the limbs are

developed on the plan of those of the Ungulates. What appear to be the front legs are each composed of two greatly developed toes; the hind "legs" consist of one toe greatly elongated, with three other toes in an almost rudimentary condition. The Dasyuridae include a series of carnivorous animals, most of which are nocturnal in habit. The Dasyures are the small native cats. *Thylacinus cynocephalus* is dog-like or wolf-like, and is the largest existing carnivorous marsupial. It is known as the Tasmanian wolf, and is at present confined to that island; but it once lived also in Victoria, and as far inland as Lake Eyre. The *Sarcophilus ursinus,* or Tasmanian Devil, is a small, fierce marsupial about the size of a badger; it also survives only in Tasmania, but at one time lived on the mainland of Australia. *Myrmecobius fasciatus,* or the striped ant-eater, belongs to a sub-family of the Dasyuridae. The animal is striped like a squirrel, and is of about the same size, and has a bushy tail. It lives on the sandy plains of Western and Central Australia, and feeds on ants. This animal has 54 teeth, which is a greater number than any other living animal, and has the teeth divided into molars, canines, and incisors; it is the living marsupial with probably the closest affinity to the fossil mammals which lived in Europe in Jurassic times.

The Notoryctidae are represented by a single form—*Notoryctes typhlops,* first described by Dr. E. C. Stirling of Adelaide; it lives amongst the sand-hills of Central Australia. It is blind, and burrows through the soil. It appears to feed on the grubs which live on the roots of acacias.

The Dasyuridae are closely allied to the American opossums, the Didelphydae, which, according to Thomas, ranks as a distinct family, mainly owing to its different geographical habitat.

The Diprotodonts, so called from the pair of large incisors in the lower jaw, include three families. The Phascolomyidae, or the wombats, are heavy and very powerful animals, which live in burrows and feed on leaves; they are somewhat badger-like in form and habits, but are much larger. The common species *Phascolomys mitchelli* was first described from some fossils found during Sir Thomas Mitchell's expedition. It lives in New South Wales, Victoria, South Australia, and Tasmania. The second family, the Phalangeridae, includes the

WOMBAT.

Australian opossums. It must be remembered that the true or American opossums are more nearly allied to the Dasyuridae. The Phalangeridae range over Australia and New Guinea, and occur among the islands of Malaysia, in Timor, Amboyna, and as far west as Celebes. The commonest opossum (*Trichosurus vulpecula*) lives among gum trees and tree-ferns, and is hunted for its fur; the Tasmanian variety (var. *fuliginosa*) is of a rich brown colour, and owing to the special value of its fur, has been so reduced in numbers that the Tasmanian Government protected it for some years, to save it from extinction. The common ring-tailed opossum (*Pseudochirus peregrinus*) lives in tea trees along the coast; its

closely allied Tasmanian representative, the *Pseudochirus*

cooki, also differs from the mainland form by the darker colour of the fur.

The native flying squirrels (*Petauroides volans*, and the smaller forms such as *Petaurus australis* and the tiny *Acrobates pygmaeus*) have the fore and hind limbs connected by a membrane. This acts, when outstretched, as a parachute, by which the animals glide through the air from tree

BASS RIVER OPOSSUM.

to tree. These flying squirrels occur in Australia and New Guinea, but not in Tasmania. They are connected with the ordinary arboreal opossums by the rare *Gymnobelideus leadbeateri,* from the Bass Range, Victoria, which is like Petaurus, but has no flying

NATIVE BEAR WITH ITS YOUNG.

membrane. The Phalangeridae also includes the koala, the Australian native bear (*Phascolarctus cinereus*), a tail-less animal, that lives high up amongst gum trees, on the leaves of which it feeds. The Tarsipes, a small mouse-sized animal, which lives in the tea trees of Westralia, is so different from the other Phalangeridae,

that it is placed in a separate sub-family, the Tarsipedinae. It has a long tail, a long pointed snout, and a long tongue, with which it catches flies and extracts honey from flowers. It is the only living marsupial which lacks the inflection of the hinder angle of the lower jaw, characteristic of the order.

The Macropodidae is the family which includes the kangaroos, wallabies, and kangaroo rats. The kangaroos are the best known and largest of existing marsupials. They vary in size; the smallest are no larger than a rabbit, while the largest (*Macropus giganteus*), when standing erect, is 6 feet high, and it weighs a couple of hundredweights. The hind limbs are much larger than the front pair, and the animal usually sits upright upon them, balanced by its powerful, muscular tail. The animal then uses its front paws as hands. The front limbs serve as legs when the animal is walking on all fours; but when running, kangaroos use only the hind limbs, with which, by a succession of long bounds, they travel, for short distances, up to the rate of nearly twenty miles an hour. That at least is the quickest pace at which I have seen them going.

Most of the kangaroos and wallabies browse on grass, and live on the open plains. Some of them keep in the shelter of the forests during the day, going on to the plains or into the glades in the evening. Dendrolagus, the tree kangaroo of New Guinea and Queensland, is, however, arboreal; and Petrogale, the rock wallaby, lives among rocks, and feeds on the leaves of scrub. Some of the smaller macropods feed on roots.

The name kangaroo was first recorded by Cook. The members of his expedition saw these animals repeatedly during their expedition along the eastern coast, and Cook gives the following account of his first sight of one:—

"As I was walking this morning at a little distance from the ship, I saw myself one of the animals which has been so often described. It was of a light mouse colour, and in size and shape very much resembling a greyhound; it

KANGAROO.

had a long tail also, which it carried like a greyhound, and I should have taken it for a wild dog if, instead of running, it had not leapt like a hare or a deer."

"This animal," he adds later, "is called by the natives kangaroo."

The Macropodidae family includes about 13 or (accepting *Halmaturus*) 14 living genera.

The living marsupials of Australia were preceded by races of gigantic forms such as the Diprotodon, and giant kangaroos such as *Palorchestes azael.* These giant marsupials became extinct in late Cainozoic, and probably in Pleistocene times.

4. Eutherea

The higher mammals of Australia belong to the orders Rodentia, Chiroptera, and Carnivora.[1] The rodents are represented by various rats and mice, including 18 species of the genus *Mus,* 6 species of *Uromys* in Northern Australia, and 1 species of *Mastacomys,* living in Tasmania, but found fossil in New South Wales. The largest rodent is *Hydromys chrysogaster*, the native water-vole. Its ally, *Xeromys,* occurs in New Guinea. The most remarkable of the Australian rodents are the Jerboa rats, belonging to the genus *Hapalotis* (*Conilurus*); there are about 15 species living in the sandy plains, about which they jump like the African jerboas.

The Chiroptera are represented by 30 species of bats.

The only Australian member of the order Carnivora is the dingo, and it is often regarded as having been introduced by man. Its remains have, however, been found in various places, as on the shores of Lake Kolungulac; in the delta of Cooper's Creek, Lake Eyre; also in the caves of Wellington and Gisborne in New South Wales, and, according to Tate, under the ash beds of Mount Gambier. They occur in deposits earlier than any containing the remains of man. It is conceivable that the dingo was landed on the northern coast of Australia

[1] For the marine mammals see pp. 148-149.

by some very early man; and that it swept through the continent with the same rapidity as the rabbit and the fox have spread since their recent introduction. But it is unlike any Asiatic dog, of which, according to Lyddeker, it most resembles the Indian pariah dogs; there is therefore zoological, as well as geological, evidence in favour of its being indigenous in Australia. The dingo probably exterminated the Thylacinus and Sarcophilus on the mainland; but as Bass Strait was already in existence, it was unable to reach Tasmania. The evidence at present rather suggests that the dingo entered Australia before the date of the human occupation, and by the same means as those which introduced the native rodents.[1]

5. The Birds of Australia

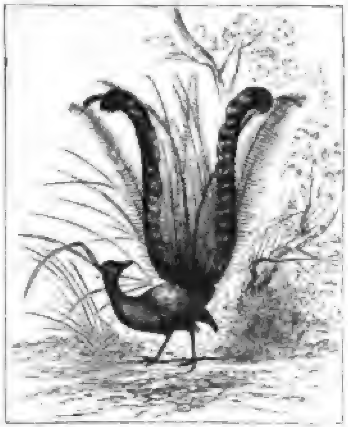
The birds of Australia, according to R. Hall's catalogue, number 770 species, and, unlike the mammals, there is no excess of special and primitive orders. The species belong to no less than 19 orders, and most of the chief groups of birds are represented. The birds, moreover, by their conspicuousness, brilliant colours, and audacity, offer a striking contrast to the mammals, which are seldom seen, as they are nocturnal and timid, and their colouring is dull and inconspicuous. The Australian birds are unrivalled among those of temperate regions for the brilliancy and vividness of their plumage, their boldness, and their quaint and interesting habits. Victoria, for example, has more gorgeously tinted birds than any other region of equally high latitudes. This is mainly due to the fact that it is connected to the tropical regions of northern Australia by continuous land; so that

[1] Mr. R. Etheridge, of the Sydney Museum, refers to its independence and wiliness, and considers it quite likely to have managed its own entry.

the tropical birds have been enabled to extend southwards; while the absence of any extensive land-mass to the south prevents these tropical birds being swamped by those with the dull plumage of temperate regions. Migrants from cooler regions do reach southern Australia; thus the Antarctic penguins are found occasionally along the coasts. The Mutton birds, which breed in vast multitudes on the islands and promontories of Bass Strait, also spend most of their time in the far south; but the land birds which are migrants from colder regions, such as the sandpipers or sharp-tailed stint (*Heteropygia acuminata*), spend the southern summer in Southern Australia and New Zealand, and return to Siberia to breed in the northern summer. The spine-tailed swift (*Chaetura caudacuta*) spends from November or December till March in southern Australia, and breeds in northern China during the Australian winter. Such migrants are naturally less abundant than in the temperate regions of the northern hemisphere, for they have to cross the whole width of the tropics.

The great variety of birds in Australia, in contrast to the small number of orders of mammals, is due to the fact that the Archipelago by which Australia is linked to Asia has enabled representatives of most of the chief groups of birds to enter the continent. The only important groups absent from Australia, but which are otherwise almost world-wide in distribution, are the vultures, the woodpeckers, and the pheasants. Their absence is more than compensated for by the presence of several groups of interesting birds which are peculiar to Australia. Of these the most famous are probably the lyre-birds, the Menuridae, of which there are 3 species, two of which occur in New South Wales and Victoria, and the third in southern Queensland. The lyre-birds

are well known, owing to their beautiful long tail-feathers and their almost unrivalled powers of mimicking the cries of other birds. They seldom fly; they mostly run on the ground, across which they can travel at great speed. They were very common in the scrub and forests of Gippsland and north-eastern Victoria, but their numbers are now being sadly diminished by the foxes. The second family peculiar to Australia is that of the scrub-birds, Atrichiidae, of which two species are found, one in southern Queensland and New South Wales and the other in western Australia. The Megapodiidae, or brush-birds, are represented by 3 genera and 4 species; most of them are restricted to northern Australia, but the Mallee fowl (*Lipoa ocellata*) lives in the scrub of Victoria, New South Wales, and western Australia. These birds are remarkable in that they do not hatch their eggs by sitting on them, but bury them in a mound, where they are hatched by the heat of the sun. The Meliphagidae is the most important family of birds peculiar to Australia. It includes 81 species. Most of them are small birds; they live by sucking honey from flowers by means of their bifid, brush-tipped tongue. Besides the birds known in Australia as the honey-eaters, this family includes the silver-eyes (*Zosterops*), the bell-bird (*Manorhina melanophrys*), the native minahs, the wattle-birds (*Acanthochaera*), and



LYRE-BIRD.

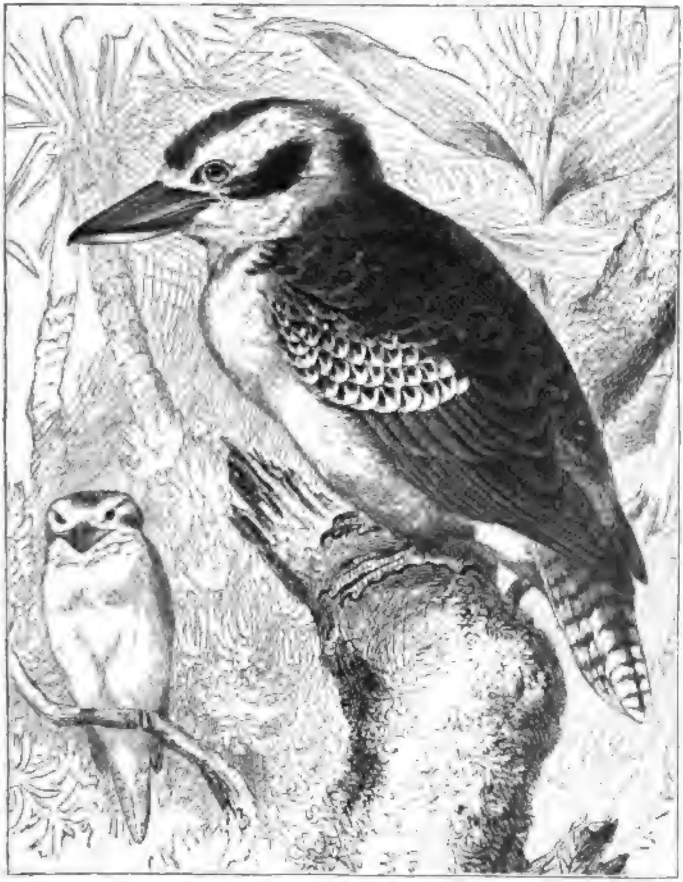
the friar-birds (*Philemon*). The Platycercinae are also restricted to Australia; they include the broad-tailed parrakeets, and the gorgeous red-headed, yellow and green coloured Rozella parrots. The bower-birds (Ptilonorhynchinae), of which there are 10 species distributed throughout Australia, are familiar from their habit of forming playgrounds, which they decorate with glistening stones, feathers, and any other brightly-coloured objects they can collect. The bower-birds in eastern Australia have, unfortunately, been greatly reduced in numbers by rabbit poisons.

Amongst the most conspicuous of the Australian birds, which belong to widely distributed families, is the great wedge-tailed eagle, or eagle-hawk (*Uroaetus audax*), which has sometimes a spread of the wings of 6½ feet. The parrots are the most conspicuous, from their brilliant colours, their tameness, and their shrill cries. They are very widely spread through the continent. They sometimes fly in enormous flocks, such as the white cockatoo; and some of the pink-headed parrakeets, when feeding on the grass, appear to tint the ground like a sheet of flowers. The number of species of parrots, lories, and parrakeets is 68.

The laughing jackass, or the kukuburra (*Dacelo gigas*), is perhaps the most popular and famous of Australian birds. It is a kingfisher, of which it is one of the largest species. They are reported to destroy great numbers of snakes by flying up with them and dropping them on the ground; but their wings are so small, and their flight is so heavy, that it is incredible that the laughing jackass could lift large snakes; but no doubt they often destroy young ones.

The Maluri, or the Australian wrens, include 16 species of small birds, characterised by the extreme

brilliancy of the colours in the males; some of them, like the blue wren, live in Tasmania and Victoria, but the



LAUGHING JACKASS.

most brilliantly coloured members of this group live in Queensland and the Northern Territory.

The magpie (*Gymnorhina*), of which the best known form is the white-backed magpie (*Gymnorhina leuconota*), ranges through south-eastern Australia and Tasmania, South Australia, and Westralia. It is famous for its charmingly melodious notes. The "morepork" (*Podargus strigoides*) is an owl-like bird, and is widely distributed throughout the continent; its popular name is derived from its cry.

The pigeons, of which the best known is probably the bronze-wing, include 26 species. The button-quails number 7 species. The cranes are represented by the native companion (*Antigone australasiana*), which is about 3 feet in height, and assembles in flocks for dances. Its nearest Australian ally is the bustard (*Eupodotis australis*). The ibises (of which there are 3 species) and the spoonbills (Platalea and Platibis) are both widely distributed. Many of the ibises migrate from Queensland to southern Australia. The swans are represented specially by the black swan (*Chenopis atrata*), vast flocks of which still live on the Gippsland lakes; while wild geese and duck are fairly plentiful throughout Australia, wherever there is standing water. The keel-less Ratite birds are represented by 4 species; they include 3 species of emu, of which the common one, *Dromaeus novaehollandiae*, is widely distributed, and the cassowary (*Casuarius australis*), which is confined to Queensland.

6. Reptiles

The reptiles are represented by four groups, the crocodiles, snakes, lizards, and turtles. The crocodiles (*Crocodilus porosus* and *Crocodilus johnstoni*) are not found further south than Queensland, but the former species

EMU.

and its extinct ally, Palimnarchus, once extended as far south as Lake Eyre; and Palimnarchus once lived in the Loddon Valley in Victoria.

Snakes are abundant on wet and swampy ground, increasing in numbers going from south to north. Most of the snakes are poisonous, especially in southern Australia, where they are practically always so. The venom is often of great strength. Thus the tiger snake (*Hoplocephalus curtus*), so called from its white stripes and its ferocity, has, according to Dr. C. J. Martin, the most poisonous venom of any known snake. This snake will, if startled, attack an opponent, although it may have an easy escape. The brown snake (*Diemenia superciliosa*) is longer than the tiger snake, and is extremely irritable.

Fortunately, the Australian snakes secrete much less venom than the cobra, and the fangs are so short that they are powerless, except when they can bite into bare flesh. There is a small annual death-rate from snake-bite; but most of the cases are due to collisions with snakes when feeling into rabbit holes, or to a snake creeping under a man's blankets in an open camp. The snakes have been greatly reduced in numbers by the clearance of the ground and by bush fires; but they still swarm in the marshes along the Murray and rivers of northern Australia, where they live upon the abundant frogs.

The diamond and carpet snakes (*Morelia*) are the largest in Australia. The carpet snakes are as much as 15 or 16 feet in length. They are not venomous, and kill their prey by crushing it. One of them appears to range southward, along the Snowy River, into Eastern Victoria.

Sea snakes occur in the rivers of Queensland and western Australia, and they are all very venomous.

The lizards include representatives of the Geckos (42 species), the Agamas (34 species), the Skinks (103 species), the Varanidae (11 species), and the legless, snake-like Pygopodidae (11 species), which family is confined to Australia. The best known of the larger lizards is called the Goana, or Iguana (*Varanus varius*). The total number of lizards enumerated in the catalogue by Lucas and Frost includes 202 species.

The Chelonia, or turtles, include 5 genera of river turtles and tortoises, such as the long-necked turtle (*Chelodina longicollis*) of the Murray, and the short-necked turtle of the rivers of southern Gippsland.

The Amphibia are represented by the frogs and toads. There are no representatives of the newts and salamanders; but toads are very numerous, and of the frogs, according to Professor Spencer, 17 species were known up to 1900.

The commonest family is the Cystignathidae, a fact of interest owing to its affinities to the frogs of South Australia. One of the most interesting groups of frogs is that of the tree frogs, the Hylidae. Most of the members of this family are of arboreal habit; but *Hyla aurea*, often called the bull frog, lives in swamps, where its deep musical clunk-clunk is one of the best known sounds in Australia.

7. Fish and Insects

The marine fish of Australia are abundant, and conspicuous from their size and danger, such as the sharks and the stingrays; their gorgeous colours, as in the parrot-fish and the "Sergeant Baker"; their quaint forms, such as the sea-horses, the pig-fish, the spined coffer-fish, and the sun-fish; or their amphibious habits,

as the tree-climbing mud-hoppers (*Periophthalmus*) of the Queensland mangrove swamps; or their excellence as food, such as the garfish, the schnapper, the whiting, and the trevally. The fish are of inferior quality to those of the North Atlantic as food; but species of true herrings (*Clupeus*), mackerels (*Scomber*), and the sole (*Solea*) occur, and no doubt, in future, increased use will be made of the vast food supplies of the Australian seas.

The most interesting Australian fish is Ceratodus, the Queensland mud-fish, which is one of the most primitive of existing fish. It is a member of the group Dipnoi, and breathes by lungs. It can thus survive long periods of drought, buried in the mud of the Queensland streams. It now survives in two Queensland rivers, the Mary and the Burnett; it is locally called "salmon." It is an old inhabitant of Australia, as its fossil teeth are found in the Jurassic rocks of the Gippsland coalfield. It was once common in the estuaries of Lake Eyre. The genus Galaxias, the fresh-water trout of Victoria, Tasmania, and South Australia, occurs in Chili, and one species is found on both sides of the South Pacific; the lampreys of the genera Mordacia and Geotria also occur in south-eastern Australia and in South America. But as both Galaxias and the lampreys breed in the sea (p. 119), their distribution is not surprising.

Of the Australian river fish, the most important, economically, is the large Murray River cod, which is really a perch (*Oligorus macquariensis*). It is largely fished for food, and is sometimes 100 lbs. in weight. The fresh-water fish of southern Victoria also occur in Tasmania, but as a rule do not occur in the tributaries of the Murray. Thus *Prototroctes*, the grayling, occurs in Tasmania and the Yarra; but the black fish (*Gadopsis marmoratus*) occurs in both the northern

and southern river systems of Victoria, as well as in Tasmania.

The invertebrates of Australia are in general of less interest than the vertebrates, but they show many points of interest in connection with geographical distribution. They include some primitive archaic animals, such as the Peripatus, which unites some of the characters of the insects and some of those of the myriapods. It lives under the bark of trees, and in moist places under stones in the woods of New South Wales, Victoria, Tasmania, and Westralia. There are 2 species, of which *P. leuckarti* occurs in Victoria, New South Wales, Tasmania, and Westralia. *Peripatus oviparus* is found only in New South Wales and Victoria. Many of the invertebrates are of types so unique that they are placed in families unknown outside Australia, such as the bell-shaped rotifer—Microdon. Many of the invertebrates give further evidence of affinity to the fauna of South America; this is especially well shown by the worms, as brought out in Professor Benham's address. The most remarkable of the Australian worms is the *Megascolides australis*, which lives in the deep swampy soils of Gippsland, and attains the length of from 5 to 6 feet. Land planarians are common, and there is one interesting land nemertean, *Geonemertes australiensis*; of the arthropods, the best known is the "Yabbie," or the crayfish (*Astacopsis bicarinatus*), which is distributed all over the continent, and is often a source of much trouble in irrigation work, as it burrows into the banks and causes a heavy loss of water by percolation. The land crab, such as the *Engaeus fossor*, is not a true crab, being more nearly allied to the crayfish. The most characteristic of the arthropods are some ancient forms, which are more widely distributed in Australia than in any other continent. They include

the shield-covered, fresh-water crustacea, including the genus *Lepidurus*, which is mostly found in the pools of the coastal district; its ally, *Apus*, is found in the interior. Both of them lay their eggs in shells, which can resist long periods of drought. The eggs lie buried in the mud until the pools are refilled by rain, when the eggs are hatched and the animals reach maturity with amazing rapidity, so that they are able to breed and lay a fresh generation of eggs before the pools have again dried up.

The insects of Australia are still insufficiently known. Lea estimates the number of beetles already known as over 10,000 species, and he expects that the total will be about 20,000 species. A thousand species have been described from Tasmania alone; 423 of them are peculiar to that island, but Lea anticipates that the percentage of peculiar species will be reduced when the beetle fauna of the highlands about Mount Kosciusko is better known. Of the insects, the praying insects (Mantidae) and the walking-stick insects (Phasmidae) are perhaps the most numerous of the less usual types.

Of the butterflies, the total number of species is said to be less than 700; but moths are very abundant, and their caterpillars sometimes occur in devastating hordes. The locusts and grasshoppers are widely distributed and very destructive. The ants are abundant, including the fierce, stinging "inch ants" or "bull ants." The white ants, which are termites and not true ants, are widely distributed. Their mounds are often seen in the Victorian forests, but they are not there as destructive as in New South Wales and in Queensland. The mollusca on the Australian shores are numerous and varied, and include many interesting forms, such as Trigonia, long since extinct in Europe, and many of the

brachiopods, a group which is now sparsely represented in British seas, though they swarmed there during the deposition of the Oolite limestones. The most important of the mollusca are the edible oysters and the pearl-oysters. The latter (*Meleagrina margaritifera*) is obtained by the pearl-fishers on the coasts of Queensland and Westralia. The shell is used as "mother of pearl," and is worth from £50 to £150 a ton. The pearls are found in the shells. The fishing fleets have their headquarters at Thursday Island and Broome; the divers are mostly Japanese and Malays. They rarely go more than seven fathoms deep.

8. The Land Animals of New Zealand

The New Zealand sub-region is characterised by the complete absence of mammals, except 2 species of bats and a rat (*Mus maorium*). This rat is believed by Thomas to be identical with the Polynesian species (*Mus exulans*); and it may have been introduced into New Zealand with the Maoris when they first entered from "Hawaiki," some seven hundred years ago. This complete absence of indigenous, non-flying mammals from New Zealand shows that the country has not been connected by land to any of the continents since the advent of mammals on the earth. New Zealand has been isolated as a true oceanic island since at least Mesozoic times. Owing to this long isolation the birds are the predominant forms of New Zealand life, and owing to the absence of their usual enemies, they have adopted unusual habits, and many of them have lost the power of flight. According to the recent summary by Professor Hutton and James Drummond, New Zealand, including the Chatham, Auckland, and other outlying islands, has

45 species of land-birds in the groups Passeres, kingfishers, cuckoos, parrots, Raptores, and doves; 38 of these species are peculiar to New Zealand. These 45 species belong to 31 genera, of which 19 are peculiar to New Zealand; so also are 2 of the families—the Stringopidae, the kakapo, and the Xenicidae, represented by the New Zealand wrens. There are two owls, the morepork and the laughing owl; the latter (*Sceloglaux albifaciës*) belongs to an endemic genus; the other belongs to the same genus as the Australian morepork.

The parrakeets all belong to the genus *Cyanorhamphus*, of which there are 4 species, and 3 more are found on the off-lying islands. This genus is also found in Polynesia; but the cockatoos, grass parrakeets, and other Australian parrots are absent; the waders are generally the most widely distributed of birds, but 10 of the 32 New Zealand species, and 4 of the 24 genera, are not found elsewhere. Of this group the most interesting forms are the wood-hen (*Ocydromus*), known as the weka, which cannot fly, and *Notornis hochstetteri*, the takahe; this bird was first described from some fossil bones, and only four specimens have yet been discovered. It was thought to have become quite extinct, until 1879, when, after a period of thirty years since the last previous record, a specimen was found on the Te Anau Downs; the fourth specimen, from the same district, was obtained in 1898, and is now in the Dunedin Museum. Another peculiarity in the bird fauna of New Zealand is that, according to Hutton and Drummond, it "is the only country in the world inhabited by 2 species of stilt-plover, neither of which is found elsewhere. Among the water-birds, cormorants are largely developed, as we possess 15 species, 12 of which are endemic. No other country

in the world possesses so many of these birds. We have 2 species of gulls found nowhere else, and this is a peculiarity of which few countries can boast. The most remarkable circumstance connected with our ducks is the presence of a species of *Fuligula,* a genus found in neither Australia nor Africa, but belonging properly to the northern parts of America, Europe, and Asia, although one species occurs in South America."

All of the known genera of penguins are found in New Zealand, and the oldest known member of this group was found in the rocks of New Zealand. The ratite or keel-less birds are still represented by five species of Apterygidae, all belonging to the genus *Apteryx*; they are popularly known as the kiwi. Their giant predecessors, the moas, can only have become extinct during the last few centuries, and were probably living at Cook's visit.

Of the reptiles, there are no snakes, but there are a few lizards, fifteen species belonging to five genera. Of these the most important is *Sphenodon punctatus,* known as the tuatara; it was once found on the main islands of New Zealand, but has been exterminated by the pigs. It survives only on some of the smaller islands in the Hauraki Gulf and in Cook Strait. This reptile is of great interest as the ally of the extinct reptiles found in Europe in Jurassic times, the nearest representative being Homoeosaurus. The Sphenodon is the most generalised of living reptiles, and has affinities to the turtles and to the Amphibia. Its most striking feature is the fact that it has a third eye on the top of the head. Of the amphibians there is only one species, the New Zealand frog, *Liopelma hochstetteri,* of which the nearest ally lives in China.

Hutton and Drummond conclude: "Taking our

fauna as a whole, we find that the elements represented are Australian, Melanesian, European, Antarctic, and South American, the last being the weakest. But our birds show only three elements, namely, Antarctic, Melanesian, and Australian."[1]

9. The Marine Mammals of Australasia

The marine mammals that live on the Australian coasts belong to the groups of the whales and dolphins, Sirenia, and sea-lions. The whales and fur-seals were formerly of considerable economic value, and they are of historic importance, as the first settlements on the southern coasts of Australia and New Zealand were made by whalers and sealers. The industry began in 1795, and was most prosperous between 1830 and 1840.

But it is now practically extinct, owing to the destruction of the herds. Whales are occasionally captured on the Australian coast, and a whale station is maintained at Twofold Bay, which whales still enter.

There are about eighteen species of Cetacea (whales and dolphins) on the coasts of Australia and New Zealand. The most important of the whales are the southern right whale (*Balaena australis*) and *Neobalaena marginata*, the smallest of the toothless whales, both of which were chased for their whalebone. The toothed whales include *Physeter macrocephalus*, which was killed for its sperm, and the orca or killer whale. The Grampus or Risso's dolphin (*Grampus griseus*) still occurs off New Zealand. One famous specimen, Pelorus Jack,[2] lives in Pelorus Sound on

[1] F. W. Hutton and James Drummond, *The Animals of New Zealand*, 1904, p. 22.

[2] Pelorus Jack is generally described as a white whale, and as such has been recorded, for example in Hutton and Drummond's *The Animals of New Zealand*, 1904, p. 51 ; but I had a sufficiently good view of it to

the northern coast of the South Island of New Zealand, and visits passing steamers. It has been so well known for years that it has been specially protected by an official statute.

The sirenian *Halicore australis* was formerly hunted on the north-eastern coast of Australia for the sake of its oil, which is said to have all the good qualities of cod-liver oil without its fishy flavour. The sea-lions or eared seals were once abundant upon the coasts of Victoria and the off-lying islands of New Zealand, such as the Auckland Islands. They still live on the Seal Rocks, at the western entrance of Western Port on the coast of Victoria, and I have seen one near the mouth of the Bass River. But they live there only because they are protected, and the industry is extinct. The species is *Arctocephalus forsteri*. The sea-lion (*Arctocephalus hookeri*) and the sea-elephant (*Macrorhinus leoninus*) still live at the Auckland Islands. The sea-leopard (*Ogmorhinus leptonyx*) occasionally visits the southern coasts of Australia and New Zealand.

10. The Botany of Australia

The first impression of the vegetation of Australia formed by a casual observer is probably one of monotony,

make a sketch of it in February 1904. It is certainly not the white whale (*Delphinapterus leucus*). As Pelorus Jack has a blunt head and a dorsal fin, it is not an ordinary dolphin (*Delphinus*), as in that genus the front of the head is produced into a pointed beak. The only point in which Pelorus Jack appeared to differ from *Grampus griseus* is in having a lower and broader dorsal fin, like that of an Orcella; but the size of the animal, the length of which I estimated as about 12 feet, and the shape of the head and the conspicuousness of the eyes agree more with Grampus than with Orcella. Its mode of swimming is strikingly unlike that of the white whales. So far as I could judge, I agree with Mr. Bates of the New Zealand Tourist Department, that it is *Grampus griseus*.

whether he sees the broad belt of tea tree that fringes most of the coasts; the vast tracts of thin open forest on sandy plains and plateaus; or the impenetrable forest-jungles on hills with a rich soil and a good rainfall. But this idea is singularly unfounded, for Australia has a flora exceptionally rich in

Photo. *A. E. Kitson.*

SAND DUNES INVADING THE FOREST OF TEA TREE.

On the coast of Victoria near Anderson's Inlet.

species, and in variety of form and habits. The number of known species of plants in Australia is about 9000, and Wallace expects that it will amount to 10,000, which is considerably more than in the flora of Europe. The general character of the forests is strikingly unlike that of Europe. The leaves wither gradually on the trees, instead of dying and falling in the autumn, and accordingly there are none of the glories of autumn

tints. The bark of many of the gums hangs around the trunks in long untidy strips, so that the trees appear to be continuously shedding their bark, instead of their leaves. The leaves hang vertically instead of being spread horizontally, as in that position they would inevitably be shrivelled by the intense heat; as further

Photo. *A. E. Kitson.*

IN A SOUTH GIPPSLAND GUM FOREST.

protections, the leaves are collected into clusters like mop-heads, hanging on the ends of the branches, and both sides of the leaves are equally well protected by a thick outer layer; and owing to the similar structure of both surfaces of the leaves, there is not the same play of light and colour as is seen in European forests. The characteristic tone of the foliage is dull or olive green; and the colour effects are contributed by the

coloured young leaves in early spring, the flowers during

Photo. *A. E. Kitson.*

IN A GUM FOREST, SOUTH GIPPSLAND.

With Black-Butt, Tree-Ferns, and Blanket-Bush.

summer, and by the bright tints of the trunks during the winter.

The first aspect of the gum forest is disappointing, and it takes some time before a visitor appreciates its charm. He cannot but notice at once the fragrance of the gum forest, which is unrivalled, and, except on windy days, the impressive silence. The exquisite beauty of some of its colour effects is evanescent and less often seen; but when the sun is reflected from the wet trunks of the white gums, they glow with vivid colours: and the flush of pure, soft pink, thrown over a vast expanse of undulating forest, when the low sun shines on the moist, young gum leaves, can be rivalled only by the sunrise glow on an Alpine snowfield. When the rata of New Zealand is in full bloom, or the Illawarra Mountains are painted red by the flowers of the flame tree (*Sterculia*), the masses of colour can only be matched in Europe in cultivated fields of mustard or clover. That the ground plants of Australia are finer in their bright colour sheets than those of Europe will probably be agreed by all who have seen the moors of Westralia when ablaze with their carpet of spring flowers.

The great wealth of the Australian flora in species occurs in the temperate parts of the continent. Thus, according to Baron von Mueller (*Second Census of Australian Plants*), the total number of Australian species known in 1890 was 8839, of which 3560 occur in western Australia, 3251 in New South Wales. According to his *Key to the System of Victorian Plants* (Melbourne, 1887 - 1888), the Victorian flora includes 1899 species, comprising:—

Dicotyledons	1371
Monocotyledons	443
Acotyledons (Rhizospermae)	5
Lycopodinae	11
Ferns	69
Total	1899

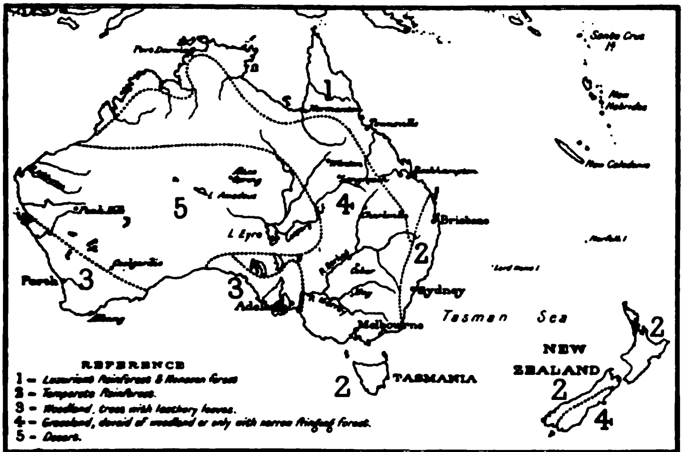
The tropical forests of Queensland are poor in species in comparison with the temperate parts of Australia.

The Australian flora is not so bizarre as may at first be thought. The gums, with their trunks littered by strips of loose bark, and their clustered leaves are less

A WOODLAND ARTIFICIALLY CLEARED FOR SETTLEMENT.

graceful than European trees; the quaint grass-trees (*Xanthorrhoea*), with their tuft of spiky leaves above a short, thick, clumsy stem, and giving off above a thin, straight flowering spike about 15 feet long; the banksias, with their bottle-brush-like flowers; the palms

and cycads; the fleshy succulent plants on the sand-dunes and in the desert; the wattles and boronias and waratahs, all combine to give the Australian vegetation a very different aspect from that of the British flora. But the apparent difference is exaggerated. The flora of the temperate parts of Australia contains a large proportion of European genera, and even many



THE DISTRIBUTION OF VEGETATION IN AUSTRALIA, ACCORDING TO SCHIMPER.

British species. The common British brake (*Pteris aquilina*) is as abundant as it is on an English common. Two hundred European genera occur in Australia, and these include most of the common British flowers. Thus the buttercups (*Ranunculus*), water-lilies, poppies, crucifers, violets, sundews (*Drosera*), St. John's worts, geraniums, mallows, roses, saxifrages, heaths, mistletoes, gentians, umbellifers, composites, campanulas, jessamines, convolvuli, verbenas, iris, lilies, rushes, sedges, grasses, are represented by plants of the same orders as in Europe.

The general characters of the Australian vegetation are governed mainly by the climatic conditions. The close dependence of the vegetation on the rainfall is illustrated by the map (p. 192) showing the distribution of the rainfall, with Schimper's map (p. 155) of the different

Photo, W. H. Ferguson.

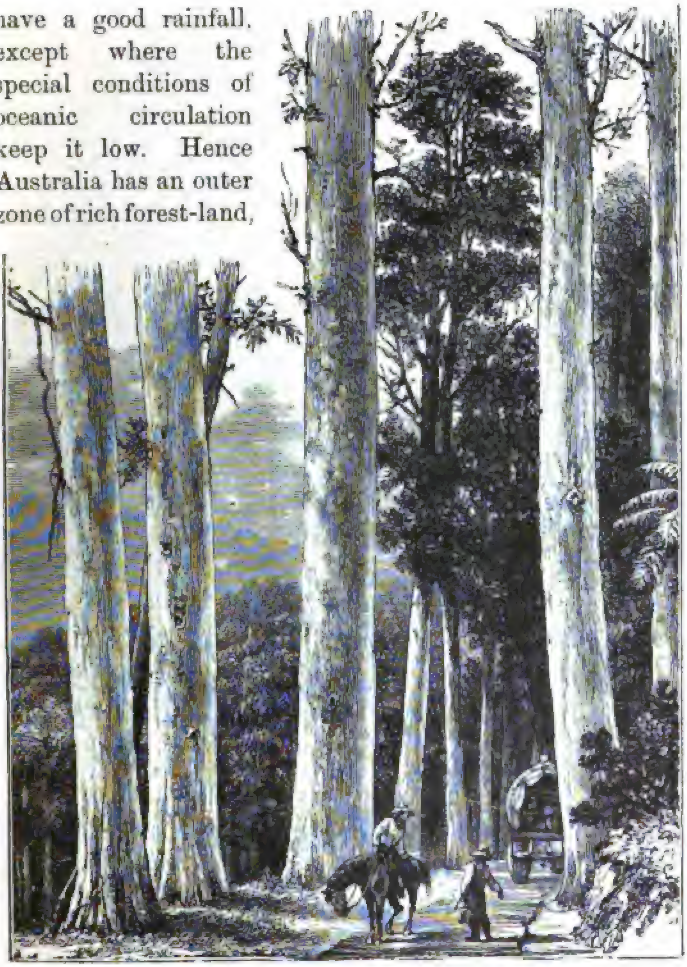
TYPICAL SPEAR-GRASS PLAIN.

On the Coastal Plain of Victoria, near Wonthaggi. Gum forest in the distance.

types of vegetation. Spencer Moore has divided the Australian flora into two elements—the xerophilous plants, which can live under arid conditions, and the hygrophilous, which require a moister atmosphere. Owing to the low rainfall of the interior, the soil has the usual remarkable fertility of that of arid regions; and after rain, the rested ground yields crops unrivalled in richness and rapidity of growth; but

they soon wither under the intense heat of a tropical or sub-tropical sun on the return of dry weather.

The coast-lands have a good rainfall, except where the special conditions of oceanic circulation keep it low. Hence Australia has an outer zone of rich forest-land,



GUM TREES.

including the almost impenetrable jungles of the Otway Ranges and South Gippsland, the tropical "scrub" of the Queensland hills, and the jarrah forests of Westralia. Behind this forest girdle the rainfall gradually diminishes

Photo. *A. E. Kitson.*

VIRGIN SCRUB OF YOUNG EUCALYPTUS TREES, NEAR BENA CAMP, VICTORIA.

inland; the forests give place to tracts of scrub, composed either of scattered gum trees or dense growths of such scrub as the mallee (*Eucalyptus dumosa*); and the rich turf of the coastal districts is replaced by scattered tufts of wire grasses on the central plains.

Australia abounds in trees and plants of exceptional

interest and value. Its chief forest trees are the gums, belonging to the genus Eucalyptus. The majority of the gums have a very hard durable wood, which is often so dense, as in the iron-bark, that the wood weighs over seventy pounds to the cubic foot, and is heavier than water, in which it sinks like stone. Owing to the hardness and toughness of gum timber, it is of great value for pavements, for piles in harbour construction; and owing to its strength and the great length in which single beams can be obtained, it is invaluable for poppet legs of mines. The Australian gums include the tallest trees in the world. They reach their greatest height in the ranges of Gippsland, to the east of Melbourne, where some trees have been recorded as over 500 feet in length, measured after they have fallen on the ground. This length is not yet authenticated. Baron von Mueller records[1] a fallen tree at Dandenong which measured, as it lay, 420 feet in length; and another on the Blacks' Spur near Healesville, he says, was shown by measurement to be 480 feet high. These tall trees belong to the species *Eucalyptus regnans*, Müll., a species which has been re-established by Maiden; though its author, Baron von Mueller, had reduced it to a variety of *Eucalyptus amygdalina*.

The leaves of some species of the Eucalyptus, when distilled, yield Eucalyptus oil.

The gums grow with great rapidity, there being two growing seasons in the year, and thus they appear to add two growth rings per year.

Among other familiar trees in Australia are the casuarinas, or she-oaks, which live on poor soils on dry plains and on rocky hills. In the latter situation they

[1] F. von Mueller, "Australian Vegetation," *Intercol. Exhib. Essays*, 1866-67, No. 5, p. 16.

are accompanied by grass trees (*Xanthorrhoea*). The acacias or wattles are very abundant, and are adapted to life in many conditions. They form a large part of the scrub in the arid deserts of the interior, while the golden wattle that lives on the river-banks and by the homesteads is probably the favourite among Australian trees.

LEAVES, FLOWERS, AND FRUIT OF *Eucalyptus amygdalina*.

The honeysuckles — the banksia — are often beautiful trees, 60 feet high, with olive-green leaves, and yellowish, bottle-brush-shaped inflorescences, which attract crowds of honey-eaters and other birds.

The tree-ferns, notably the *Dicksonia antarctica*, which lives in wet gullies, often give some of the Gippsland forests a tropical aspect, although some of these ferns live buried in snow for four months in the year. Other tree-ferns, *Alsophila australis*, *Todea africana*, and *Cyathea cunninghami*, live in more open and drier situations. The stems of the tree-ferns are often clothed with *Trichomanes* and other filmy ferns. Palms occur in tropical Australia. They are conspicuous along the coasts of Queensland and northern New South Wales; but they reach eastern Victoria, and isolated colonies live on the mountains of Central Australia.

Photo. *A. E. Kitson.*

TREE-FERNS IN A RINGED GUM FOREST ON JUMBUNNA CREEK, VICTORIA.

The open plains, whether covered by turf or tufts of dry grass, are rich in flowering plants.

The lovely waratah, one of the Proteaceae, is sometimes described as the national flower of New South Wales, and another species occurs in Tasmania and on the coast of Victoria, as at Waratah Bay. Shrubs of boronia (another favourite national flower), with their scented, dull coloured, but prettily shaped bells and feathery foliage, are common around Sydney and in Westralia, and eight species occur in Victoria.

The heaths, which mostly belong to the family of the Epacridaceae, are before all the most typical of the Australian bushes, and include the Tasmanian cranberry and the native currants. They are nearly related to the Ericaceae, or the heaths of Europe, which are represented by a few species, two occurring, for example, in Victoria. The Goodeniaceae are related to the European campanulas, a family represented by *Wahlenbergia gracilis*, the Australian bell-flower, one of the most conspicuous flowers in the lava plains in southern Australia.

CHAPTER VI

THE GEOGRAPHICAL RELATIONS OF THE AUSTRALIAN FAUNA AND FLORA

1. The Biological Position and Subdivisions of Australasia

THE animals and plants of Australia and New Zealand are of especial scientific interest, for their characters are so exceptional that the Australasian region is now generally regarded as a division zoologically equivalent to the rest of the world, excluding South America. The three primary regions of the world from a zoological standpoint are (1) Australasia, including Polynesia, (2) South America, and (3) the rest of the world. This threefold division was founded by Huxley in 1868. Before that time zoologists universally accepted the six zoological regions established by P. L. Sclater in 1858 [1] in the classic essay which is the starting-point of all modern discussion of zoological geography. According to Sclater's scheme, Australia, New Guinea, and the adjacent islands were grouped together as the Australian region. Sclater's system has been followed, with amendments, by Dr. A. Russel Wallace in his two works, *The Geographical Distribution of Animals* (1876) and his *Island Life* (1880, second edition 1892), and with still

[1] P. L. Sclater, "On the General Geographic Distribution of the Members of the Class Aves," *Journ. Linn. Soc.*, Zool. ii. (1858), pp. 130-145.

further modifications by Dr. R. B. Sharpe, also in reference only to the evidence of birds, in 1893.[1] Sclater's classification was based mainly on the passerine birds. Professor Huxley's[2] was the result of a study of game-birds, which led him to realise the striking affinities between the faunas of Australasia and South America. He united them into one zoological group under the name of Notogaea. The rest of the world he grouped together as Arctogaea. Notogaea he subdivided into three subdivisions—the Australasian, the Novo-Zelanian (for New Zealand), and the Austro-Columbian (for South America).

Huxley's view that Australia is a division of equal rank with Europe, Asia, Africa, and North America together has been widely adopted. It is advocated by Dr. W. T. Blanford, in the influential address[3] which first clearly showed that the evidence of zoological distribution can only be used as a guide to the former distribution of land and water, if the evidence of different groups of animals is considered in relation to the dates at which those groups first came into existence. The evidences given by an ancient and by a modern group of animals are not equivalent. In 1896 Dr. Lydekker,[4] whose opinion is of especial importance, as his conclusions are founded upon a full knowledge of the geographical distribution of the fossil land vertebrate animals, also accepts the threefold division of the world. He adopts Huxley's term Notogaea in a modified sense, as he excludes South America from it. He divides the world into three realms, of which the Notogaeic realm is divided into three regions—the Australian (including

[1] R. B. Sharpe, "On the Zoo-Geographical Areas of the World, illustrating the Distribution of Birds," *Nat. Sci.* iii. (1893), pp. 100-108.

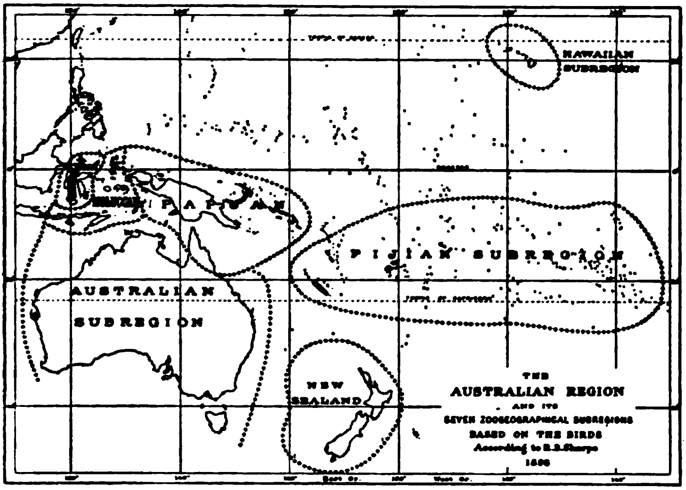
[2] Huxley, *Proc. Zool. Soc.*, 1868, pp. 294-319.

[3] Blanford, *Proc. Geol. Soc.*, 1890, pp. 43-110.

[4] R. Lydekker, *A Geographical History of Mammals*, 1896.

New Guinea), the Polynesian (including New Zealand, etc.), and the Austro-Malayan (including Celebes).

Though Australia is thus biologically separated from the rest of the world by exceptionally well-marked features, it overlaps with other areas in so many points that opinion is not agreed either as to the exact



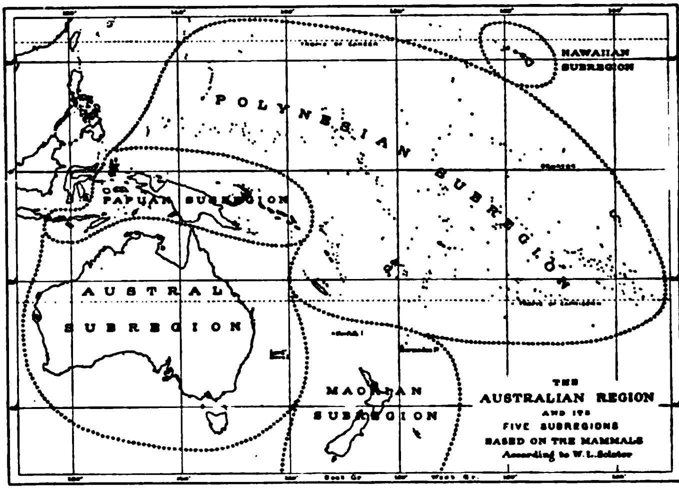
THE ZOOLOGICAL SUB-REGIONS OF AUSTRALASIA, ACCORDING TO DR. R. B. SHARPE.

boundaries of the Australasian region as to its subdivisions, or as to the continent with which it was last connected. Two recent subdivisions of the Australasian regions, as proposed by R. B. Sharpe on the birds, and by W. L. Sclater on the mammals, are shown by maps.

According to Wallace,[1] Australia was last connected with Asia, from which it has been isolated since Mesozoic times. Thus its special biological interest would be as the land of refuge of survivors from the Mesozoic life of

[1] A. R. Wallace, *Island Life*, 1880 (second edition, 1892).

northern lands. This view is based on the fact that the predominant mammals of Australia are marsupials, which became extinct in Britain in the Mesozoic, and in Europe in Eocene times. The Australian fresh-water fish include the Ceratodus, which lived in Europe in the Triassic and Jurassic; and the doubly armed herrings,



THE ZOOLOGICAL SUB-REGIONS OF AUSTRALASIA, ACCORDING TO W. L. SCLATER.

Diplomystus, which were thought to have become extinct long ago, until they were discovered living in the rivers of New South Wales. The survival of Mesozoic types in the Australian seas may be illustrated by the Carcharodon, the Port Jackson shark; Trigonia, the most characteristic of Jurassic lamellibranchs; and an abundance of brachiopoda of Mesozoic aspect.

Botanical evidence has also been adduced in support of the archaic character of Australian life. The vast preponderance of gums in the forests, the non-deciduous

nature of the foliage, and the very small number of seeds produced by each flower, have been advanced as evidence of the primitive character of the Australian flora. This opinion, according to Moore,[1] was the result of "bias imparted by" the zoological data, and he emphatically denies the inferiority of Australian vegetation.[2] "In what respect," he asks, "is the flora of Australia less highly specialised? Are not most of the great natural orders strong constituents of it? Trees—some of them of gigantic size—shrubs, undershrubs and herbs, parasites and saprophytes, climbing and carnivorous species, flowers adapted to profit by the visits of insects, and sometimes provided with a complex mechanism to ensure such profit, all these are met with in Australia. In addition, we have wonderful adaptations to a dry climate, and in this respect, taking into account the variety of ways in which the destructive effects of a scorching sun and parched soil are guarded against, the Australian flora is without a parallel the world over. And if these be not evidences of high specialisation, it is difficult to know where to look for such."

2. The Biological Affinities with South America

It must be at least admitted that the case for the isolation of Australia since Jurassic times and the primitive character of its fauna rests in the main or the zoological evidence. Recent opinion has not supported Wallace's view. Huxley, with his fine insight, recognised so many points in common between the faunas of South America and Australia, that he

[1] Spencer Moore, "Suggestions upon the Origin of the Australian Flora," *Nat. Sci.* xv. (1899), p. 198.

[2] Spencer Moore, *op. cit.* p. 207.

united them in one zoological region, Notogaea; and though his Austro-Malayan or South American subdivision of his Notogaea has since been separated as a primary division of the world, many fresh links between the faunas of South America and Australia have been discovered.

As is so often the case, the piece of evidence that has made the widest general impression is of no value. The occurrence of the fresh-water trout of the genus Galaxias in the rivers of south-eastern Australia, Tasmania, New Zealand, South Africa, and South America, has been quoted repeatedly as evidence of a former land connection between South America and Australia. And this land connection should have been of quite recent date, for one species (*G. attenuatus*) is found in the rivers of Australia, Tasmania, the Falkland Islands, and Chili.

In vain did Wallace,[1] with sound judgment, protest that no such land connection could have existed within the life of this one species of fish, "because such a connection must have led to much more numerous and important cases of similarity of natural productions than we actually find. Rather must we look to the transport of the ova across the southern seas, aided perhaps by the Antarctic ice, and a former greater extension of South America towards the Pole." So much evidence was accumulating in favour of the land connection, that the arguments founded on *G. attenuatus* have been widely accepted. But this fish would prove so much too much, that it really proves nothing; for it is inconceivable that if there had been a land connection across the Eastern Pacific in the lifetime of that species, that many other

[1] *Geographical Distribution of Animals*, vol. i. pp. 401, 402. See also vol. ii. pp. 82-83.

species should not have been common to the two areas. Dr. Boulenger has now given a simple explanation of the range of the Galaxias, as he reports that it breeds in the sea; so its occurrence in any rivers opening to the Southern Ocean and the Southern Pacific is easily understood.

There is, however, abundant evidence of a connection at some time between South America and Australia, either by a land extending across the Pacific along the line of the Polynesian archipelago, or by a more southern antarctic land. This connection has been affirmed by specialists in different branches of zoology. Thus, Lydekker holds that a land connection between Australia and South America is required by the discovery of the fossil marsupials in Patagonia, to which may be added the discovery of the diprotodont, *Coenolestes*, still living in South America. Lydekker concludes:[1] "Assuming that the Patagonian dasyurids are more or less allied to the Australian forms (and this certainly appears to be the case), it may be taken for granted that they have not originated independently. From considerations advanced in the next chapter, it is almost impossible to believe that they travelled by way of North America; and if this be so, their only mode of migration would be by means of a land bridge between South America and Australia by way of the antarctic continent, or possibly in a zone nearer the Equator. Assuming such a connection to have existed in Tertiary times (and there is no reason why it should not have existed), it must either have taken place before the development of the diprotodonts in Australia, or must have been in such high latitudes, or so transitory, as to permit of the passage of only a few forms."

[1] R. Lydekker, *A Geographical History of Mammals*, 1896, pp. 55-56.

The evidence of the earthworms supports the same conclusion. Thus Beddard,[1] after a summary of their distribution, tells us that "the former existence of a habitable antarctic continent with arms stretching to New Zealand, Africa, and Patagonia seems to be the clearest way of explaining these facts."

Benham advocates the existence of an Antarctic land connecting Australia with South Africa and South America in later Mesozoic times, to explain the distribution of earthworms. Von Graff has arrived at similar conclusions from the study of another group of worms—the Planarians. The Antarctic connection was first suggested by Sir William Hooker on the evidence of the flora of Tasmania, and he is supported by Spencer Moore from the problems of the South Africa flora; by H. O. Forbes, who first published a suggested map of the continent, to explain the distribution of fossil birds; and by Moreno from the presence of a fossil land-turtle (Miolania) in Lord Howe Island, in Queensland, and South America. The theory has been supported from consideration of the general evidence by Blanford, Hedley, Hutton, Osborne, and Spencer.

There are two alternative routes for the biological connection between South America and Australasia—a southern Antarctic land, or, what is perhaps more probable, a land extending from Melanesia southward to New Zealand, and eastward along the chain of the Polynesian Archipelago to the submerged Patagonian platform. The success of the Funafuti coral boring, achieved by Professor David and Mr. Sweet, and its confirmation of Darwin's theory that the South Pacific coral islands mark the site of a sunken land, gives

[1] F. E. Beddard, "Earthworms and the Earth's History," *Nat. Sci.* iii. 1893, p. 111.

fresh support to this position of the connecting land. Lydekker[1] considers it possible that the land connection between Patagonia and Australia was *via* Polynesia, and this may have been the line through which Notogaea [Australasia] received the South American elements in its fauna. He admits that it is impossible to say whether that connection existed at a date sufficiently late for the passage of marsupials. "Possibly," he says, "there may have been a land connection between Patagonia and Australia *via* Polynesia; and this may have been the line through which Neogaea [S. America] received the Notogaeic elements in its fauna. Whether it could have existed at a date sufficiently late for the passage of the marsupials, it is impossible to say. If it existed, it probably allowed only a limited communication between the Notogaeic and Neogaeic mammals; and it is easy to imagine that the Polynesian mammals (if they existed) were drowned out by submergence, as has undoubtedly been the case with many of those of the West Indies. In dismissing this part of the subject it may be observed that it appears impossible to adequately explain the presence of a Notogaeic element in the fauna of Neogaea without the aid of some form of southern land connection; although there is not sufficient evidence to show in what latitude such connection (or connections) existed."

3. The last connection of Australia with Asia and Malaysia

Not only is it probable that there was a Cainozoic land connection between Australasia and South America, but there is strong evidence in favour of the connection

[1] R. Lydekker, *A Geographical History of Mammals*, pp. 126-127.

of Australia and Asia in post-Mesozoic times. Thus, according to Benham, Australia has two elements in its earthworm fauna. One—the Acanthodrilids—he believes to have originated in the Melanesian plateau, whence New Zealand and the adjacent islands (Benham's Antipodea) were separated in lower Cretaceous times. From Melanesia the Acanthodrilid earthworms entered New Guinea and thus reached Australia, while others entered a Mesozoic, Antarctic land, by which they reached South Africa and South America. Australia, according to Benham, was early separated from the antarctic land, and subsequently in early Cainozoic time was connected to south-eastern Asia, whence it received a fauna of Cryptodrilid earthworms, which have almost exterminated the Acanthodrilids.

Thus, according to Benham, the last connection of Australia was with Asia. Lydekker would make this connection even later than Benham; for he maintains that the flightless ratite birds are a group of modern development; and that they required a direct land connection with Asia, where they are found fossil in Upper Cainozoic deposits. He believes that the marsupials entered at the same date, and that they also require a comparatively late Cainozoic connection between Australia and Asia. The rats and the dingo were probably introduced by natural agencies from Asia, for the dingo existed in south-eastern Australia before man lived there.

At some time New Guinea was undoubtedly connected with Queensland; and therefore many of the tropical plants and animals of New Guinea invaded Queensland. They remain there as the Papuan element in Australia, which thus received a contingent of the flora and fauna which peopled New Zealand. The

strength of this invasion of Australia by the New Guinea plants and animals is such that, Hedley says, "in the heart of the great Queensland 'scrub' a naturalist could scarcely answer from his surroundings whether he were in New Guinea or Australia."

4. The Relations of the Floras of Australia and New Zealand

The relations of the animals and plants of Australia to those of New Zealand were first clearly discussed in Sir Joseph Hooker's[1] classic memoirs on the Floras of Australia, of New Zealand, and of Tasmania. He pointed out the extraordinary richness of the Australian flora, and the surprising fact that the south-western part of the continent, in spite of its more uniform geographical conditions and more arid soil, is botanically much richer than the varied countries of eastern Australia. Sir Joseph Hooker, moreover, was the first to point out the striking differences between the floras of New Zealand and Australia. Hooker's conclusions were confirmed by the further great additions to the Australian flora made by Bentham[2] and von Mueller. To Dr. Russel Wallace we owe a discussion of the distribution of both animals and plants; and his work led him to some fascinating theories, which have, however, failed to gain final acceptance, as they are inconsistent with the later geological history of Australia. Wallace's views were developed first in his *Geographical Distribu-*

[1] J. D. Hooker, "Introductory Essay to the Flora of New Zealand," 1853, in the *Flora Antarctica*, vol. ii. pt. 1, pp. i-xxxix. See also his *Handbook of the New Zealand Flora*, 1867. And "On the Flora of Australia" in *Flora Tasmaniae*, vol. i. 1860, pp. xxvii-cxxviii.

[2] Bentham and von Mueller, *Flora Australiensis*, 7 vols. 1863-78. Von Mueller, *Fragmenta Phytographiaea Australiae*, 11 vols. 1861-84.

tion of Animals, and again later in his *Island Life*. Wallace maintained that the New Zealand flora had been derived from Australia, as all the natural orders found in New Zealand occur in Australia. Of 310 New Zealand genera 248 are Australian, and 60 of them are almost peculiar to the two countries. In many cases the genera in the two countries are the same, but the species are distinct; so there must, he considers, have been some connection between the two regions by which the plants crossed; and this connection must have been severed so long ago that the species have since had time to change. In spite of this evidence in favour of the connection of Australia and New Zealand, it is a fact that a large number of the most characteristic and commonest of the Australian genera are quite absent from New Zealand, which has no acacia nor Eucalyptus, nor tea tree of the genus Melaleuca. "There are in Australia," says Wallace,[1] "seven great genera of plants, each containing more than 100 species, all widely spread over the country and all highly characteristic Australian forms—Acacia, Eucalyptus, Melaleuca, Leucopogon, Stylidium, Grevillea, and Hakea. These are entirely absent from New Zealand, except one species of Leucopogon, a genus which also has representatives in the Malayan and Pacific Islands. Sixteen more Australian genera have over 50 species each, and of these 8 are totally absent from New Zealand, 5 are represented by one or two species, and only 2 are fairly represented; but these 2 — Drosera and Helichrysum — are very widespread genera, which might have reached New Zealand from other countries than Australia.

"But this by no means exhausts the differences between New Zealand and Australia. No less than 7

[1] A. R. Wallace, *Island Life*, 2nd ed., 1892, pp. 489-491.

Australian Natural orders—Dilleniaceae, Buettneriaceae, Polygaleae, Tremandreae, Casuarineae, Haemodoraceae, and Xyrideae are entirely wanting in New Zealand, and several others which are excessively abundant and highly characteristic of the former country are very poorly represented in the latter. Thus, Leguminosae are extremely abundant in Australia, where there are over 1000 species belonging to about 100 genera, many of them altogether peculiar to the country; yet in New Zealand this great order is most scantily represented, there being only 5 genera and 13 species; and only two of these genera, Swainsonia and Clianthus, are Australian, and as the latter consists of but 2 species, it may as well have passed from New Zealand to Australia as the other way, or more probably from some third country to them both. Goodeniaceae, with 10 genera and 220 species Australian, has but 2 species in New Zealand, and one of these is a salt-marsh plant found also in Tasmania and in Chile; and 4 other large Australian orders—Rhamneae, Myoporineae, Proteaceae, and Santalaceae—have very few representatives in New Zealand. We find, then, that the great fact we have to explain and account for is the undoubted affinity of the New Zealand flora to that of Australia, but an affinity almost exclusively confined to the least predominant and least peculiar portion of that flora, leaving the most predominant, most characteristic, and most widely distributed portion absolutely unrepresented."

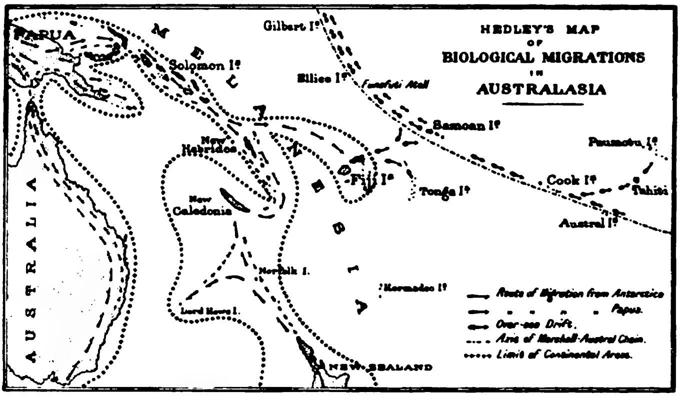
Wallace explained this apparent anomaly by the hypothesis that Australia, in early Cainozoic times, was divided into two parts by a sea which extended southward from the Gulf of Carpentaria and the Timor Sea across the basin of Lake Eyre, and through the valley of the Murray to the Southern Ocean, in South Australia

and western Victoria. To the west of this sea is the ancient plateau of western Australia; and Wallace regarded this area as the nursery in which developed the characteristic types of Australian vegetation. To the east of this trans-Australian sea rose the lands of eastern Australia; they, according to Wallace, extended in a long narrow strip from Cape York across eastern New South Wales and eastern Victoria to Tasmania, whence it projected still further south. The flora of eastern Australia was then assumed to be a mixture of three distinct elements—an Antarctic element, which worked its way northward through Tasmania from some great land area to the south; secondly, a tropical contingent, which crossed from New Guinea into Queensland; the third contingent was composed of stragglers from the Australian flora, which were wafted across the sea from western Australia. Wallace holds that New Zealand was connected with eastern Australia before its occupation by the Australian vegetation, which was still confined to its western home; this flora could not, therefore, reach New Zealand. Moreover, as New Zealand was joined to Queensland, it received a flora in which tropical characters predominated. South-eastern Australia was at this time under more temperate conditions, and it received a large influx of plants from lands that then existed to the south of Australia. Wallace accepts the importance of the former temperate flora in New South Wales from the work of Baron von Ettingshausen; he asserted, on the evidence of fossil leaves, the existence there of many common European trees, including the willow, the oak, the birch, the alder, and the hazel, which are not now found in Australia. These identifications have, however, been discredited by the careful work of Mr. Deane, and need no further consideration.

The more recent writers on the Australian fauna and flora have endeavoured to explain the difficulties without assuming the existence of any isolation of eastern and western Australia by a sea; and if they can do so, their views have certainly the advantage of better agreement with geological evidence. For there is no evidence of a sea having divided Australia into two parts in Cainozoic times. Hedley admits the possible existence of such a sea in the Cretaceous period; that also may now be discredited, as it is most probable that the Cretaceous sea which extended southward from the Gulf of Carpentaria only reached as far as the northern end of Lake Torrens, and a broad land to the south of it connected western and eastern Australia.

Hedley points out that geological evidence shows that eastern Australia had already a distinctively Australasian flora in early Cainozoic times, and that it was occupied by the Australian mammals, according to de Vis, in early Pliocene times. Hence he objects to Wallace's assumption that the distinctively Australian plants were at one time found only in western Australia. He maintains, moreover, that though the fauna of New Zealand approximates in some respects to that of Queensland, it has not been derived thence; the relationship, as he puts it, is not that of mother and daughter, but that of sisters. The operculate land mollusca of New Zealand, instead of being allied to those of Queensland, could hardly be more distinct, the genera being quite different in the two countries. He concludes, therefore, that New Zealand derived its fauna and flora from land occupying the present site of the Melanesian platform. This Melanesian land, which included the Solomon Islands, New Caledonia, the Fijis, and Lord Howe Island, was not directly connected with Australia, but only indirectly through New

Guinea, which was then, doubtless, connected with Queensland. Therefore many of the tropical plants and animals of New Guinea invaded Queensland, where they still remain as the Papuan element in the fauna of the Australian continent. The typical Australian vegetation, and especially that adapted to life in the arid plains, could not have passed across the tropical portion of the Melanesian land into New Zealand. This theory ex-



ROUTES OF THE BIOLOGICAL MIGRATIONS IN AUSTRALASIA
(According to C. Hedley).

plains the tropical aspect of the vegetation found in the temperate regions of New Zealand, for its flora is all of tropical origin.

Of the proposed zoological subdivisions of Australia the chief are those of Wallace, Tate, Spencer, and Hedley. Wallace proposed the fundamental separation of eastern Australia and western Australia. This arrangement has been adversely criticised by Hedley, who makes the primary division of the Australian faunas into the Papuan,

which crossed Torres Strait from New Guinea, and the non-Papuan. The Papuan now occupies Queensland. "The types encountered by a traveller in tropical Queensland, or rather in that narrow belt of tropical Queensland hemmed in between the Cordillera and the Pacific, all wear a foreign aspect. Among the mammals may be instanced the cuscus and tree kangaroo; among reptiles, the crocodile, the Rana or true frog, and the tree snakes; among birds, the cassowary and rifle birds; among butterflies, the Ornithoptera; among plants, the wild banana, orange, and mangosteen, the rhododendron, the epiphytic orchids, and the palms; so that, in the heart of a great Queensland 'scrub,' a naturalist could scarcely answer from his surroundings whether he were in New Guinea or Australia. It may be supposed that late in the Tertiary epoch Torres Strait, now only a few fathoms deep, was upheaved, and that a stream of Papuan life poured into Australia across the bridge so made." For the non-Papuan division Hedley accepts the classification of Professor Tate, who recognises what he called the Autochthonous fauna of western Australia as the aboriginal Australian fauna. He believes that it probably entered Australia from the Austro-Malayan Islands in or before the Cretaceous, and accordingly contains many ancient forms, some of which, such as the earthworms of the western Australian fauna, have affinities with that of Ceylon. South-eastern Australia and Tasmania form the Bassian province of Spencer; the Euronotian of Tate occupies the same area, but extends farther to the north. The third division of the continent accepted by Eyre and Spencer is the Euronotian or Eyrean, which occurs in the arid regions of the centre and the west.

The biological provinces of Australia are limited by direct climatic control. The southward march of

the Papuan flora was checked by the colder regions of Australia, where it was unable to compete successfully with better suited aboriginal inhabitants. The climatic control of the distribution of the plants and animals in Australia may be illustrated by comparison of Schimper's map (p. 155), showing the distribution of types of vegetation in Australasia, with the map showing the distribution of the rainfall (p. 192). Mr. Spencer Moore, in his interesting paper on the "Origin of the Australian Flora," emphatically rejects the view that it is in any way inferior, or less specialised, than that of the northern regions, and he maintains that the well-marked differences between the generally adopted botanical subdivisions are due to climatic control.

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CHAPTER VII

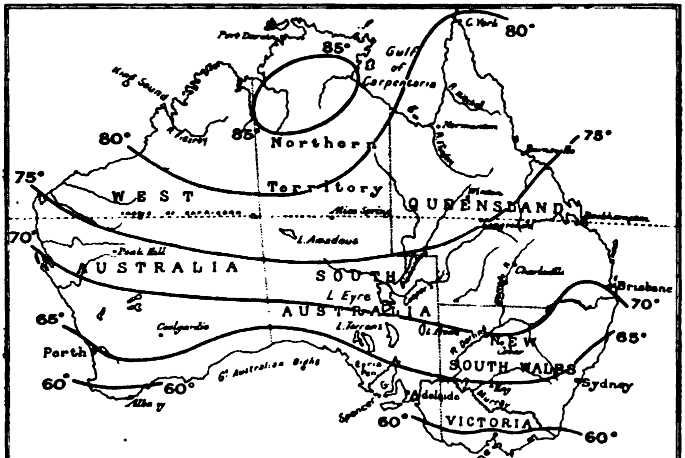
THE CLIMATE OF AUSTRALIA

AUSTRALIA has a less varied climate than any other continent, as its greatest length extends from east to west; as it is surrounded on all sides by the ocean; as it has only a moderate range in latitude (10° 39′ S. to 39° 11½′ S.); as it is crossed at almost its widest point by the tropic of Capricorn, which passes near the central point of the continent; and as its general level is uniform. As the northern part of Australia is within the tropics, and most of the rest is sub-tropical, only the southern section of the mainland and Tasmania have the climate of the temperate zone.

The governing factors in the climate in Australia are, in the first place, its latitude, and the gradual passage from the tropical climate of northern Australia to the temperate conditions along the southern coast. The second important factor is the elevation of the land; for the fact that much of Australia consists of a plateau lowers its temperature. The third dominant factor in the distribution of climate within Australia is distance from the sea; for the interior has a more arid climate than the well-watered coastal girdle.

According to Supan, Australia can be divided into four climatic provinces; the tropical portion of northern

Australia is included in the region affected by the Indo-Australian monsoon; the eastern parts of Queensland, New South Wales, and Victoria, and all Tasmania belong to the "East Australian Province"; the south-western



MEAN ANNUAL TEMPERATURE
FAHRENHEIT'S SCALE

corner of Westralia forms another province; and the rest of the continent forms the province of Inner Australia.

1. The Winds and Cyclonic Systems

The general climatic conditions are governed by the fact that northern Australia lies within the influence of the monsoons of the Indian Ocean, while all southern Australia lies in the belt of the variable westerly winds. The weather is determined by the passage across Australia of a succession of cyclones and anticyclones, which enter

Australia from the Indian Ocean, traverse the continent from west to east, and pass out into the Pacific Ocean. The weather is determined by the path followed by these great atmospheric disturbances. At times the anticyclones pass on a northern track, and thus exclude the monsoonal rains from the continent. While under these conditions, southern Australia lies open to the cold, wet weather brought in by the cyclones from the Southern Ocean. At other times the anticyclones follow along a southern path, and the monsoonal influences and the monsoonal rains spread southward far into the continent. Hot winds from the north sweep across the continents in the valley of low pressure lying between two successive anticyclones.

There is a seasonal variation in the path of the anticyclones and cyclones due to the fact that the thermal equator moves southward with the sun. Hence in January it is much further south than in July. The trade winds also move southward with the thermal equator, and the belt of variable winds is thus pushed farther to the south. Hence the cyclone path across Australia lies farther south in summer than in winter; and the hot winds from the tropics can sweep southward across Australia more freely than in winter. Moreover, the summer in Central Australia is the wet season, because in the summer the land is heated, the air above it expands, the upper air flows outward toward the colder areas over the sea. Thus, Central Australia in summer is a low-pressure area, and is under cyclonic conditions. Accordingly, the warm moist winds from the ocean can travel further into Australia in summer than in winter. These moist winds, for the reasons already stated, find their easiest entrance from the north. Thus the monsoonal rains extend right across

the centre of Australia, and even contribute largely to the summer rains of northern Victoria. In winter, on the other hand, the continent is under high pressure, or anticyclonic conditions, because the land becomes cooled more quickly than the sea; the air above it is cooled and condensed; fresh air flows in above to fill in the depression thus caused in the upper regions of the

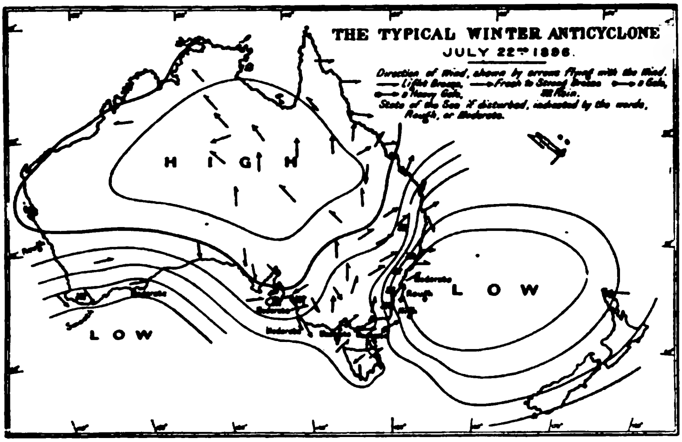
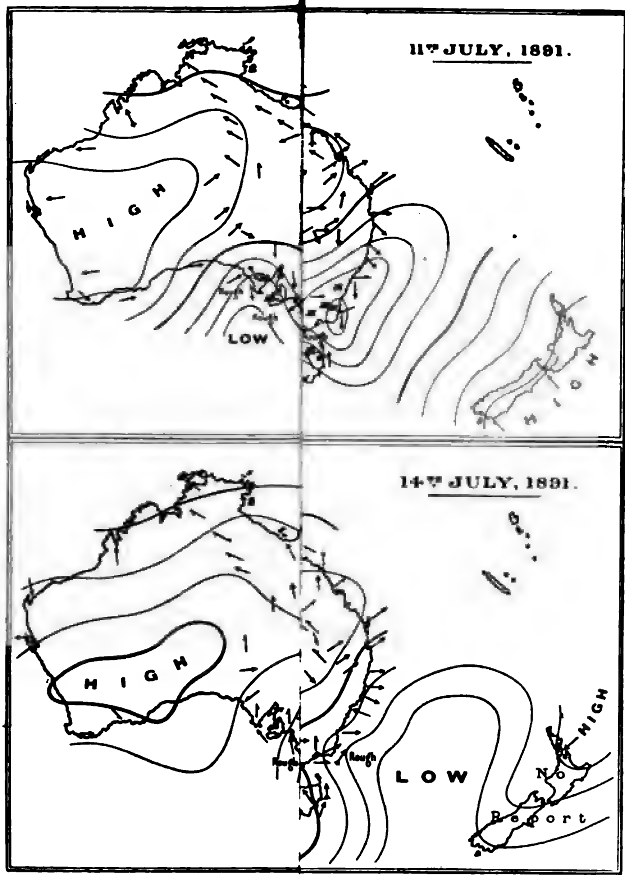


CHART OF A TYPICAL WINTER ANTICYCLONE. (AFTER P. BARACCHI.)

atmosphere; the barometric pressure is high, and winds blow outward to the sea; and there is no indraft of moist sea-breezes.

The climatic conditions which govern the Australian weather can be illustrated by a series of weather charts showing the passage of a series of these atmospheric disturbances across the continent. These charts, for which I am indebted to Mr. P. Baracchi, Government Astronomer of Victoria, are reproduced from my *Geography of Victoria.* The first set illustrate the passage of an anticyclone which

crossed Australia from the 10th to the 14th of July, 1891. On 10th July the eastern part of New South Wales lay under an anticyclone, which was passing eastward on to the Tasman Sea. Westralia was under the influence of the eastern half of another anticyclone, which was just crossing from the Indian Ocean. Between the two anticyclones a low-pressure valley extended across the continent, the pressure being lowest over the area of Spencer Gulf. The weather there was accordingly very rough, with cold winds from the south, along the western side of the anticyclone, and strong wind from the north upon its eastern side. The next day, 11th July, the first anticyclone had moved from New South Wales to New Zealand; and the following anticyclone had spread out as a long band of high pressure, extending more than halfway across the continent. The low-pressure area or cyclone had now moved eastward to cover Tasmania, the east of Victoria, and the eastern part of New South Wales. On the 13th the conditions had not materially changed, though the succeeding anticyclone had broadened out over Westralia, and reached the southern coast, and it was roughly triangular in form. Tasmania and Victoria were still under the rough stormy influences of the cyclone, which remained almost stationary over the Tasman Sea. By 14th July the eastward movement of the series was still very sluggish. The centre of the cyclone was now in the centre of the Tasman Sea; Victoria, New South Wales, and Tasmania, were still under the influence of its western margin. The centre of the succeeding anticyclone was over the head of the Australian Bight; the low-pressure area to the east of it enabled the cold winds and rains from the Southern Ocean to sweep northward over western Victoria and New South Wales. South-eastern



CHARTS RE? BARACCHI). P. 186.

Australia still lay under the stormy influences of the cyclone. Owing to its sluggish movement to the east, the rains were long continued, leading to the disastrous floods of July 1891. The progress of this cyclone system was somewhat abnormal; for, instead of continuing its steady eastward progress, it was detained for two days, and the heavy rains were continued longer than they usually are.

The summer conditions of the Australian weather are illustrated by a series of four charts showing the passage of the cyclonic system, from the 7th to the 12th January 1897. The first of this series of charts shows that the whole of Central Australia was under the influence of a valley of low pressure, widely open to the north. This valley narrowed to the south between two anticyclones, one of which crossed Australia along the southern coast, and still lay over the Tasman Sea. The second anticyclone was just beginning to affect the south-western corner of Australia, following along the same southern track as its predecessor. By the next day (8th) the succeeding anticyclone had pushed its way along the southern coast of Westralia to the Great Bight. Its predecessor had passed eastward, so that its centre was over New Zealand. The cyclone was now a great triangular area of low pressure covering northern Australia; and warm winds flowed southward along it as far as Spencer Gulf. On 9th January the advancing anticyclone had travelled eastward, its centre being a little distance to the south of Australia, and its eastern border had reached Adelaide. A low-pressure area covered Tasmania, and extended in the form of an inverted Λ over Victoria into New South Wales. Southern Victoria was therefore receiving heavy rains from the south; at the same time a broad cyclone with a long, flat southern

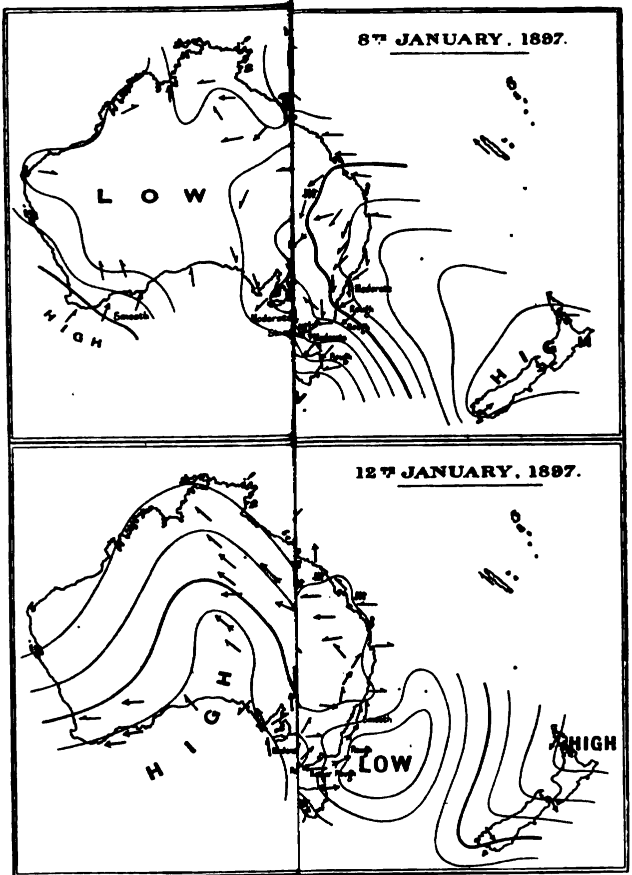
margin covered the Northern Territory of South Australia, and was connected by a valley with the Victorian cyclone. By January 12th both the cyclones had moved eastward; the one on to the Tasman Sea, and the other from the Northern Territory on to Queensland; and practically the whole of the southern coast of Australia enjoyed fine weather owing to the advance of the anticyclone.

The gusty, changeable weather of spring and autumn in southern Australia is due to the passage of atmospheric systems of which the edges are very sinuous. They are therefore said to be "festooned." The wind blows in an eddy in each loop of the festoons; and thus the passage of such an atmospheric system is marked by rapid oscillations of the barometer and extremely squally, changeable winds.

One of the most striking features of the winds of Australia are the hot winds of summer, which blow sometimes for a few hours, or in some cases for a few days, and owing to their extreme heat and dryness are unpleasant to experience and may be destructive to crops. Thus on one occasion, in December 1828, a hot wind destroyed all the wheat along the banks of the Hunter River for a distance of 30 miles.[1]

These winds are sometimes called "brick-fielders," owing to the amount of red dust which they carry. They all blow from the interior of the continent, but their cause varies in different localities. At Melbourne they are due to the passage of a long narrow cyclone, extending from north to south across Australia between two anticyclones. The cyclone forms a trough of low pressure, along which the north wind from the heated interior can travel southward to the coast. These hot winds are therefore usually suddenly

[1] H. C. Russell, *Climate of New South Wales*, 1877, p. 17.



CHARTS [illegible] P. BARACCHI).

reversed, and followed by cold winds from the south. This change of direction is sometimes regarded as monsoonal in origin; but it belongs to an entirely different cause, being cyclonic. In the front half of an Australian cyclone the wind is travelling from north to south; and the back half is travelling from south to north. The cyclone may be travelling forward at the rate of fifty miles an hour, so that the passage from the northern wind of the front part to the southern wind of the hinder part may be experienced within a few minutes. The strong north wind, with its clouds of dust and its parching dryness, suddenly falls; there are a few minutes of dead calm; then the trees, left bending to the south, are suddenly flung northward, and there is a rush of cold moist air from the south, under which the temperature may fall twenty degrees in the course of twenty or thirty minutes.

The conditions at Sydney are somewhat more complex, because Sydney is on the margin of the belt of the Trade Winds, and it is under the shelter of the high cliffs of the Blue Mountains. Along this part of the coastal district of New South Wales the Trade Winds blow at low levels from the south-east to the north-west, and cross the coastal district as cold, moist winds. High overhead, the Return Trade Wind blows from north-west to south-east, as may be recognised by the movements of the light upper clouds, which are being carried in the opposite direction to that of the wind on the ground. The Return Trade Wind is increased in its power by the north-westerly monsoon; and the air brought south-eastward by the monsoon is warm, and it becomes still hotter by passage across the heated plains of Central Australia. This high-level wind, therefore, passes across Sydney at a temperature which

varies from 80° to 110°, but which is very seldom above ·100°. Inland, however, this wind is very much hotter, and Russell accepts the temperatures as sometimes exceeding even 130° in the shade. This heated high-level wind is frequently blowing across Sydney; but it is very seldom felt directly on the ground. For Sydney is sheltered by the Blue Mountains, which raise the hot wind high above sea-level; and therefore a cool sea-breeze generally blows in from the north-east.

This high-level hot wind is so powerful that it no doubt crosses the Tasman Sea to New Zealand, which it reaches as a very wet wind, owing to its absorption of moisture from the sea. Its existence therefore explains the extreme wetness of the western coast of New Zealand, and is the primary, indirect cause of the hot winds which sweep across the Canterbury Plains from the north-west (see p. 603).

Direct proof of the arrival of this wind in New Zealand is afforded by the fall there of red dust, identical—except for its finer grade—with that of the red rain of Victoria, which is shown by its included diatoms to have been derived from the Central Plains of Australia.[1]

Sydney, however, protected by its north-eastern winds, seldom feels the effects of the hot north-west wind from the interior; but at times of especial heat in the tropics the north-east wind is suspended, and then the hot inland wind falls over the scarp of the Blue Mountains on to the coastal plains. Even then, Sydney feels this wind only for a short time. For it can only reach Sydney in consequence of a fall in the barometer there, owing to the stoppage of the north-east wind; and

[1] See F. Chapman and H. J. Grayson, "On Red Rain, with Special Reference to its Occurrence in Victoria," *Vict. Nat.* xx. 1903, p. 29.

the same cause which lets down the hot air from above, brings up a cold wind from the south. Sydney is therefore promptly rescued from the heat wave by the arrival of a cold "southerly buster."

The dust storms of Australia result from the passage of these hot winds over ground which is parched and dry, so that dust is easily lifted and swept along by the wind. The electrical repulsion between the dry particles of dust helps to keep them scattered through the air. The dust carried by these storms is often moved for great distances, as is shown by the fall in New Zealand of rain tinted red by dust picked up in the Central Australian Plains. In the drought of 1902 the Riverina was in places denuded of its soil, which was blown away, leaving bare swept patches of the underlying "cemented" surface, and carried southward to fertilise the northern plains of Victoria.

The dust storms are naturally most severe on the plains of the interior, and they are well known in the proximity of towns such as Coolgardie and Broken Hill.

The Willy-willies of the north-western coast, which are cyclones travelling inland from the ocean, are often terribly destructive, tearing away roofs and wrecking towns.

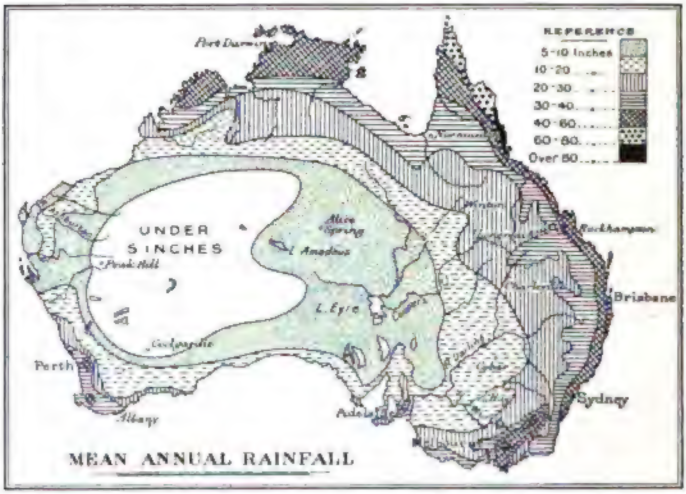
The effects of wind erosion on the bare rocks of the Australian hills is one of the most characteristic features of Australian scenery.

2. The Rainfall

The rainfall of Australia, as shown in map (p. 192) is very irregular in distribution. It is on the whole fair in quantity in the coastal districts, whence the amount falls steadily as we advance inland. Thus the mean annual

rainfall at Portland, on the Victorian coast, is 34·67 inches; at Hamilton, 40 miles to the north, it is 26·73 inches; 100 miles farther north, at Nhill, it is 16·87 inches; and at Mildura, on the bank of the Murray, 155 miles north of Nhill, it is only 10·91 inches.

The decrease of rain, going inland from the coast in



MEAN ANNUAL RAINFALL

New South Wales, is shown in a table by Russell.[1] At Kiandra, which is the highest station north of Kosciusko, and 88 miles from the east coast, the precipitation, including snowfall, is but slightly below that recorded at the Cordeaux River, 6 miles from the coast. With this exception, there is a fairly regular fall, from 60 inches on the coast, to 13 inches at Wentworth, 476 miles inland. The same fact may be shown by a line drawn from any point of the interior of Central Australia toward the

[1] H. C. Russell, *The Climate of New South Wales*, Appendix, Table 20, p. 46, 1877.

coast. The only considerable area where the rainfall is higher inland than on the coast is in the mountains of south-eastern Australia, where the precipitation on the Alps may exceed 60 inches, whereas at adjacent points on the coast it may fall to 30 or 40 inches.

No part of Australia is absolutely rainless. The driest parts of Central Australia appear to have a mean rainfall of about 6 inches.

In New South Wales the rainfall varies from a mean of 8·8 inches at Milparinka, on the far western plains, to that of 77 inches at Ballina, at the mouth of the Richmond River.

In Victoria the average for the whole State, taken to the end of 1900, is 26·68 inches, giving a total rainfall for the whole State ranging from 28 cubic miles of water in 1888 up to 46 cubic miles in 1887. The highest for any one locality in Victoria is 96 inches, recorded at Woods Point in 1887. The lowest which has been recorded was at Yelta on the Murray, which in 1888 was 4·46 inches. The lowest mean record in Victoria is that at Minafree, in the county of Karkarooc, where the average of six years' observations (all that are available) is 10·76 inches.[1]

On the western coast of Australia the violent changes of temperature found in eastern Australia are practically unknown; the coast-lands are affected by a daily monsoonal change of wind, cool sea-breezes blowing in every evening. The rain mostly falls on the west coast of Australia between May and September. It falls in heavy showers. The average annual rainfall for Perth is 83 inches.

Westralia has two areas of good rainfall, separated by a dry belt. The wettest district is the south-western

[1] J. W. Gregory, *Geography of Victoria*, 1903, pp. 236-238.

corner, where the average for the district is 38 inches a year. It is slightly higher at various localities. Thus along the Darling Range there are occasional wet patches, as in the Canning Valley, where, near the Coolgardie reservoir, the average is 42 inches. In the extreme north the monsoons give the Kimberley district an average rainfall of from 20 to 27 inches. Between these areas the rainfall falls to an average, estimated by Cooke, the Government Astronomer for Westralia, at only 6 or 7 inches.

South Australia is also an arid State; large tracts in the interior have an average rainfall of about 5 or 6 inches.

Tasmania, on the other hand, has the heaviest average rainfall, as its high mountains precipitate the moisture which is being carried eastward by the westerly winds. The rainfall at Lake Margaret, near Mount Lyell, sometimes exceeds 140 inches in the year, and it sometimes rains steadily for a fortnight. The miners of Mount Lyell say that "the average length of a shower is three months."

In the interior of Australia, though the average rainfall amounts to some inches, it is very uncertain in its distribution. It mostly falls in the summer, as the rain is monsoonal in origin; but at times, when the ground is overheated, the monsoonal clouds may be swept across the country and be unable to precipitate their moisture. Mr. Kempe of the Peak Station assured me that in the thirteen months previous to February 1902 the only rain that had been recorded by the gauge at his station was one fall of $\frac{1}{10}$th of an inch.

Snow falls in south-eastern Australia during the winter. There is one record of it having lain on the ground in Sydney. It falls in Melbourne at intervals of a few years, but scarcely lies on the ground. But it

may be seen from Melbourne on the mountains, 20 or 40 miles away, and it is very heavy every winter in the Alps of north-eastern Victoria and of southern New South Wales. The tree-ferns in the highland gum forests lie buried in snow for several months during the year. The high plateau of north-eastern Victoria is covered with deep snow, which may last from May to September; and some of it remains till midsummer in gullies and sheltered positions on the southern faces of the hills; and showers of snow may occur at any time during the year. The snow is so thick on these high plains that traffic is only possible in winter on Norwegian snow-shoes, or "ski," in the use of which the miners are expert. Ski races are amongst the attractions of the winter sports at Kiandra and the other mining towns in this district. Snow is also very heavy in the highlands of Tasmania. There is no mountain bearing perpetual snow in either Australia or Tasmania.

The rate of evaporation in Australia is often extremely high, and it far exceeds the rainfall in the dry plains of the interior. The Inter-State Commission on the Murray calculated that the evaporation from Lakes Alexandrina and Albert at the mouth of the Murray amounts to an average of 42,000,000,000 cubic feet per annum. The officers of the Water Supply Department of Victoria accept a possible evaporation of 10 feet per annum in the Mallee district of north-western Victoria; and Sir Charles Todd, the Government Astronomer of South Australia, reports an even higher figure from the rain-gauges under his care in Central Australia.

The annual evaporation at Sydney, according to Russell,[1] as a mean for 17 years' observations, is 48·6 inches.

[1] H. C. Russell, *Climate of New South Wales*, Appendix, p. 44.

3. Temperatures

The mean temperature of Australia, as a whole, is moderate; and that of many places, such as Perth, is always temperate. In the interior, on the other hand, the temperature is sometimes unusually high. Temperatures of over 130° in the shade are registered in localities which are outside the tropics. Sturt states that in November 1845 his thermometer, which was graduated to 127°, though placed for protection on the fork of a tree, burst owing to the heat; and he recorded the temperature as 131° in the shade on 21st of January 1845. According to W. E. Cooke,[1] the highest shade temperature recorded at Perth was 116·7° in January 1878. In January, the hottest month of the year, the average maximum temperature for the day is 88·1°, and the average minimum for the night 62·6°. For July, the coldest month, the average maximum for the day is 63·9°, and the average minimum for the night 45·8°.

At Coolgardie the mean maximum day temperature is 97·5°, while at Southern Cross, in July, the mean minimum night temperature falls to 38°; but though frosts are not infrequent, snow and ice in that district are practically unknown.

In Central Australia, in the winter, the temperature during the day is delightful; but at night it falls considerably below freezing-point, and water left exposed in any vessel may be frozen.

The mean temperature for Melbourne in January is 66°, and the extremes recorded for that month are 111° and 42°. In July, the coldest month, the mean is 47·6°,

[1] In M. A. C. Fraser, *Western Australian Year-Book for* 1898-99, vol. i. (1900), pp. 112-113.

which varies from the maximum record of 68° to the minimum of 27°. The coldest record of any station in Victoria is at Omeo, where in July, 16·5° has been recorded; but the temperature must often be lower on the high exposed plateaus. In northern Victoria, and on the Murray, the temperature is much hotter; thus at Mildura, in January, the mean rises to 76·5°, varying from 120° down to 42°, while in July the mean is 49·3°, varying from a maximum of 85° to a minimum of 28·51°; but a temperature of 26° has been observed there in June.

4. Floods and Droughts

Owing to the irregularity of the rainfall, the Australian rivers are liable to devastating floods, the effects of which have been particularly disastrous along the eastern coast, especially in the Hunter and Brisbane Rivers. In the latter case elaborate works have been proposed in order to prevent the occurrence of the floods. The floods come with some periodicity between intervals of drought. A Royal Commission on the floods in the Hunter River reported[1] that the river in 1820 rose 37 feet above high water; in 1832, to about 29 feet above high water; in 1857, to 29 feet; and in June 1867, to 30 feet above high water. The Hawkesbury River, in April 1860, rose 36·8 feet above the mean tide level.[2] In 1864 it rose to 47·4 feet above; in 1867, to 62·7 feet; in 1870, to 44·4 feet; in 1895, to 38·2 feet. The highest floods of the Darling were in 1848, 1852, 1863, 1864, 1867, 1870, 1871, 1873, 1879, 1886, and 1893.

The cyclonic control of Australian weather is well

[1] See H. C. Russell, *Climate of New South Wales*, 1877, p. 36.

[2] *Ibid.* p. 39.

marked in its effect on the distribution of the rainfall; and it explains why the interior of the continent may be suffering from drought in periods of exceptionally heavy rainfall on the coast. Gippsland, for instance, may enjoy a good season, while the Mallee country has a bad one.

The explanation of this oscillation between the interior and the coastal districts is the fact that, when the anticyclones are especially well developed and the barometric pressure is high on the continent, the oceans are under cyclonic conditions. Anticyclonic conditions result in dry weather, and cyclonic conditions are marked by heavy rainfall. Hence when the centre of the continent is under anticyclonic conditions and is comparatively dry, the coastal regions are sharing the extra rain of the cyclonic conditions then prevalent over the sea. Hence when the centres of the continents are under prevalent anticyclonic conditions and have dry years, the coastal regions are under prevalent cyclonic conditions and have wet years. This fact is very well brought out, for instance, in Russell's map showing the distribution of the rainfall of New South Wales for 1899, in which the coastal regions had a rainfall above the average, while the whole of the inland regions had only their average, or less than their average. This fact can be illustrated by the diagram (shown on p. 199), reproduced from the *Climate of Australasia*, contrasting the rainfalls at Sydney and at Bourke in the interior of New South Wales.

Though there are one or two exceptions, the general rule is for the rainfall to be above the average at Bourke when it is below the average at Sydney. The same fact can be shown by a diagram contrasting the average rainfalls at Sydney and at Adelaide.[1]

[1] J. W. Gregory, *Climate of Australasia*, 1903, p. 63.

This fact serves to explain the apparently capricious rainfall of Melbourne, which shares in both the coastal and the continental rainfalls.

The periodicity in Australia has been considerably discussed. Egeson, in 1889, maintained that there was a cycle in the Sydney weather of from thirty-three to thirty-four years, a period which is almost the same as that demonstrated in Bruckner's great work,

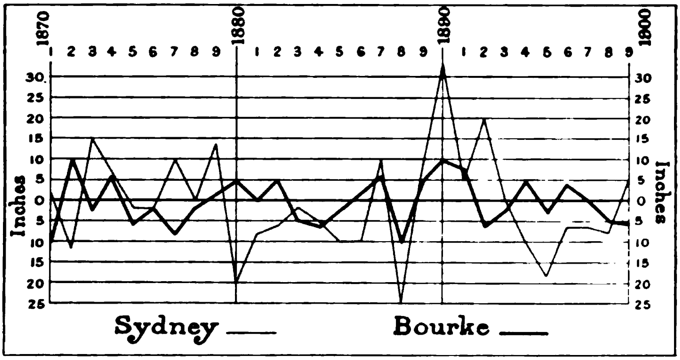


DIAGRAM OF THE RAINFALL AT SYDNEY AND BOURKE.

Klimaschwankungen. Russell,[1] on the other hand, was in favour of a cycle of nineteen years. The records are not yet sufficient to establish fully the Bruckner period for Australia, but they furnish many striking facts in agreement with it.

The probable control of the Australian weather by variations in the circulation and temperatures of the surrounding oceans has recently been advocated; and, with a view to proper investigation of the question, it is to be hoped that Australia will arrange for a united

[1] H. C. Russell, "On the Periodicity of Good and Bad Seasons," *Proc. R. Soc. N.S. Wales*, xxx. 1897, pp. 70-115.

meteorological service for the whole Commonwealth. The Federal Government has the power to undertake this work. It is necessary that the same meteorological methods should be adopted over the whole continent. Such a service would, no doubt, give better results than those yielded by the present separate services; and the economies effected by the saving of overlap and duplication could be applied to filling in the deplorable gaps in the knowledge of Australian meteorology.

The chief works of reference on Australian weather are the reports of the Government astronomers or meteorologists of the different States. The most valuable are the "Annual Reports on Results of Rain, River, and Evaporation Observations made in New South Wales," by H. C. Russell of Sydney; they give tables of the rainfall for most of the Australian stations. Unfortunately this serial appears to be discontinued. Russell's *Climate of New South Wales*, 1877 (2nd edition, 1892), gives an admirable account of the data up to that date.

For the Southern Ocean, the best compilation of information is in the "Meteorological Charts of the Southern Ocean between the Cape of Good Hope and New Zealand," issued by the Meteorological Council, London, 1899.

References to recent literature are given by the author in *The Climate of Australia in reference to its Control by the Southern Ocean*. Melbourne, 1904. The following is some of the recent literature:—

Meeson, John T. "On the Characteristics of the Nor'westers of Canterbury, New Zealand," *Rep. Austr. Assoc. Adv. Sci.* iii. (1891), pp. 72-79, 593-595.

Nelson, Hugh M. "On the Climate of Australia" (Anniversary Address to the Royal Geographical Society of Australasia, Queensland), xvii. (1901-2), pp. 144-158.

Noble, A. "The Development of Meteorology in Australia," *Monthly Weather Review*, vol. xxxiii. No. ii. November 1905, pp. 480-484.

Russell, H. C. "Moving Anticyclones in the Southern Hemisphere," *Quart. Journ. R. Met. Soc.* xix. 1893.

Todd, C. "Meteorological Work in Australia: A Review," *Rep. Austr. Assoc. Adv. Sci.* v. (1894), pp. 246-270, pl. vi.

Hunt, Henry A. "Types of Australian Weather," *Journ. and Proc. R. Socs. New South Wales*, xxix. (1895), pp. 513-551.

Wragge, Clement. "The Snowy Ranges of Australia, Mount Kosciusko and its Observatory," *Journ. Manchester Geog. Soc.* xvii. (1901), pp. 111-123.

—1902. Queensland. No. 1, Report on the Mount Kosciusko Observatory and Allied Stations. Brisbane, 1902. pp. 26.

CHAPTER VIII

THE ABORIGINES

1. The Australian Aborigines

THE Australian aborigines are perhaps the most interesting of living uncivilised races of mankind, as the insular position of the continent, and the protection afforded to the inland tribes by the difficulties of desert travel, have sheltered them from foreign influences.

The country offered to the occasional visitors who may have landed on the Australian coast no particular inducement to travel inland, even had the way been easy. Moreover, since the British occupation of the continent, the tribes of the interior have been comparatively slightly influenced in their modes of thought; for missionary enterprise has been but slightly developed in Australia.

The aborigines of Central Australia are therefore perhaps the last remaining people who have worked out their own culture free from foreign influence.

It does not follow that their beliefs and ways are primitive, for they may have undergone steady development to suit the unusual geographical conditions of their environment. It is true that the aborigines have been generally regarded as the most degraded and most primitive of mankind, a view based on the erroneous reports of the first observers.

Dampier, describing an aborigine from the north-western coast, said that: "His painting adding very much to his natural Deformity; for they were all of them of the most unpleasant Looks and the worst Features of any People that ever I saw, tho' I have seen great variety of Savages. These N. Hollanders were probably the same sort of People as those I met with on this Coast in my Voyage round the World [see vol. i. p. 464, etc.]; for the Place I then touch'd at was not above 40 or 50 Leagues to the N.E. of this: And these were much the same blinking Creatures (here being also abundance of the same kind of Flesh-flies teizing them) and with the same black Skins, and Hair frizled, tall and thin, etc., as those were: but we had not the opportunity to see whether these, as the former, wanted two of their fore-Teeth."[1]

The unfavourable account of the aborigines given in this the first British description of them was strengthened by the reports of the settlers in Australia. They were not brought into very close relations with the aborigines, and naturally formed a low opinion of them. The aborigines appeared to have no personal property, or houses, to live in small family groups which had few dealings with outsiders, and to indulge in the wildest sexual license amongst themselves. They lived solely on wild game or fruits, for they had no domestic animals and never tilled the soil. They would eat anything they could find. They had no chiefs, as in the organised despotisms of the South Sea Islands. They had no images which they appeared to worship. Their weapons were made solely of wood, bone, and stone, and were of the simplest types; for the aborigines did not even know

[1] William Dampier, *A Voyage to New Holland, etc., in the Year 1699*, vol. iii. p. 148. London, 1703.

the use of the bow and arrow. The facts obvious to a casual observer showed a people living in unorganised, nomadic hunting packs. There was nothing to show their mental capacity, their elaborate social system, their poetical imaginations, and their intense belief in spirits. Their simple life and political system were forced on the aborigines by the hard conditions of the sterile, arid plains of Central Australia; and their customs, though probably adaptations, were not unnaturally regarded as archaic.

AFFINITIES.—The affinities of the aborigines were at first considered (*e.g.* by Cuvier) to be with the Negroes, with whom they agree somewhat in colour, in the largeness of the teeth, the prominence of the jaws and lips, their long skulls and calfless legs. The apparent broadness of the nose, another negroid feature, is, however, artificial, being to some extent increased by the use of the nose-peg; their noses have unusually wide alæ.

The negroid characters, however, were small and non-essential in comparison to more significant differences, such as their abundant, coarse, long, straight hair.

Huxley's description of the aborigines may still be quoted as an excellent summary.[1]

"THE AUSTRALOID TYPE.—The males of this type are commonly of fair stature, with well-developed torso and arms, but relatively and absolutely slender legs. The colour of the skin is some shade of chocolate-brown, and the eyes are very dark brown or black. The hair is usually raven black, fine and silky in texture; and it is never woolly, but usually wavy and tolerably long. The beard is sometimes well developed, as is the hair upon

[1] T. H. Huxley, "On the Geographical Distribution of the Chief Modifications of Mankind," *Jour. Ethn. Soc.* 1870, pp. 404-405.

the body and the eyebrows. The Australians are invariably dolichocephalic, the cranial index rarely exceeding 75 or 76, and often not amounting to more than

Photo. *H. J. Grayson.*

DALBIRIKA, A MEMBER OF THE YAUROKA TRIBE, AGED ABOUT FORTY YEARS.

From Cooper's Creek, north-east of Lake Eyre.

71 or 72. The brow ridges are strong and prominent, though the frontal sinuses are in general very small or absent. The *norma occipitalis* is usually sharply pentagonal. The nose is broad rather than flat; the jaws

are heavy, and the lips remarkably coarse and flexible. There is usually strongly marked alveolar prognathism. The teeth are large, and the fangs usually stronger and

Photo. H. J. Grayson.

KINTALAKADI, A MEMBER OF THE TIRARI TRIBE, AGE ABOUT FORTY YEARS.

From the eastern shore of Lake Eyre.

more distinctly marked than in other forms of mankind. The outlet of the male pelvis is remarkably narrow." . . . "The only people out of Australia who present the chief characteristics of the Australians in a well-marked form

are the so-called hill-tribes who inhabit the interior of the Dekhan in Hindostan. An ordinary coolie, such as may be seen among the crew of any recently returned

Photo. *H. J. Grayson.*

WOLPILINA, A YANTRUWUNTA.

From the north-east side of Lake Gregory.

East Indiaman, if he were stripped to the skin, would pass muster very well for an Australian, though he is ordinarily less coarse in skull and jaw."

The ancient Egyptian was another allied race, and it shared with the Australian the use of the

boomerang and the throwing-stick. Huxley shows that the physical features of the Egyptians were Aus-

QUEENSLAND NATIVE.

traloid. He says, "Although the Egyptian has been modified by civilisation, and probably by admixture, he

still retains the dark skin, the black, silky, wavy hair, the long skull, the fleshy lips, and broadish alæ of the nose which we know distinguished his remote ancestors, and which cause both him and them to approach the Australian and the 'Dasyu' more nearly than they do any other form of mankind."

Huxley clearly realised that the aborigines were not nearly connected with the negroes, that they are characterised by a remarkable uniformity in race, and that their nearest allies are some of the tribes of Central India. An alternative theory that has been widely advocated is that the Australians are a hybrid race, due to the invasion of Australia by a race of black Caucasians, who fused with the aboriginal negroid or negrito race which was then in occupation, and of which the Tasmanians were the last representatives. According to Mathew, moreover, the Northern Australians have been further altered by extensive intermarriage with Malays.

The theory of the origin of the Australians as hybrids between black Caucasians and negroid Tasmanians was advocated in Flower and Lydekker's *Mammalia*. It has also been adopted by Spencer and Gillen, Roth and Howitt.[1] But there is no evidence of the close relationship of the Australians with the Tasmanians. The two races are quite unlike in their skull characters and in their hair. I am not aware of any case in which a pure Australian has the woolly hair of the Tasmanians, or of any aboriginal skull which suggests any admixture of Tasmanian blood; a few hybrids have occurred in Southern Victoria, probably descended from Tasmanians introduced by the sealers or other early European visitors. As maintained by Dr. Russel Wallace,[2]

[1] Also by myself in 1903. *Geography of Victoria*, pp. 243-244.

[2] *Australasia*, edit. 1893, pp. 152-3.

and again recently by Lydekker,[1] and accepted by the great majority of British opinion, the Australians are a race of Caucasians allied to the hill-tribes of Southern India. Their allies include the Veddas of Ceylon, the Hairy Ainu of Japan, and the ancient Egyptians. They probably crossed into Australia at an early period, first occupied Northern Australia, and thence worked their way southward on three main lines. During life in the Central Plains they became specialised to suit desert conditions. The dry arid climate led to the development of muscular, thin bodies; the extreme glare may have led to the recession of the eyes and the increased depth of the notch above the nose; and the coarse food led to the development of the teeth and corresponding increase in the size of the jaws.

MENTAL CHARACTERS.—Mentally, the aborigines are characterised by their kindly, peaceful, and amiable dispositions. They are nervous and shy of strangers, but are perhaps one of the most amiably disposed of native races. They have repeatedly saved the lives of travellers who have been lost in their country, whom they have fed and protected for years. "To see an Australian aborigine at his best," says Barton, "take an average unsophisticated myall, one of those who, near the present site of Townsville, rescued Murrells and his party from shipwreck and befriended him for eighteen years; like those among whom Peter Buckley had spent over thirty years before Melbourne was founded; like those in whose company Narcisse Pelletier, the French sailor-boy, during six years felt so thoroughly content that he could scarcely be prevailed to leave them; like those who fed and tended King, the sole survivor of the bungled Burke and Wills expedition, until relief came."[2]

[1] R. Lydekker, *Knowledge*, vol. xxiii. 1900, pp. 6-9.

[2] C. H. Barton, *Outlines of Australian Physiography*, 1895, pp. 161-162.

They are, moreover, extremely kind to their children and to the aged members of their tribes, who, when too old to walk, they may carry about on stretchers.

Like many native races they are excitable, and they have frequently attacked Europeans; probably these fights have always been either in answer to aggression, from nervousness, or to avenge some unwitting infringement of sacred, tribal taboo. Their reception of considerate Europeans has nearly always been friendly, until they were driven into hostility by the destruction of their food-supply, with the advance of pastoral settlement. They have never given any serious trouble, for their small numbers, and their inability to mass, rendered them powerless. They made no effort to resist the occupation of Australia, for they never occupied more than a scanty area of land, and were ready to allow any newcomer to settle on any that was not in use.

WEAPONS.—Their culture is certainly primitive; the most archaic character is the fact that they are provided only with weapons of wood, stone, and bone. So also, we must remember, were the Maoris, one of the most civilised and advanced of native races. The most characteristic Australian weapon is the boomerang, a curved bar of hard, heavy wood, usually between 3 and 6 feet in length. It is thrown with remarkable accuracy, and inflicts a sufficient blow to kill any native bird and smaller animal, and disable an adversary, or one of the larger kangaroos. The smaller boomerang, which is used in sport and games, whirls through the air and returns to the thrower. But this instrument is rather a toy, and is not used in war or in serious hunting. They also use long spears, 10 feet or more in length, armed with points of either hard wood, bone, or stone. These spears are thrown by hand, or may be used for thrusting.

The northern tribes increase the range of the spears by the use of the spear-thrower, a wooden bar or plate, which has a notch or projection at one end that fits against the base of the spear. It adds a third joint to the arm and thus greatly increases the leverage, and gives the spear a much higher initial velocity, and consequently a great increase in range and accuracy of aim.

The club, usually a simple knob-headed stick, is one of the chief weapons. The yam-stick, a thick, pointed, often slightly curved stick, with which the women dig the ground for roots, is sometimes used as a club. The chief weapon of defence is a thick wooden shield, with which boomerangs or spears can be warded off.

IMPLEMENTS.—The chief cutting tools are made of stone. The stone axes or tomahawks are oval, elliptical or rectangular in shape, with a sharp cutting edge, usually ground at one end. The axes may be held in the hand, or firmly mounted on the end of a wooden handle like an axe with a cement made from the exudation of the grass trees. Those used in the hand have a blunt, rounded end which fits against the palm of the hand; one of the chief uses of this tool is to cut notches in trees while climbing. Small stones are chipped into the form of scrapers for skins, knives for cutting open game, or scrapers for shaping wood. The stone spear-heads are chipped and lance shaped. The stone used varies in different districts. Where a suitable stone occurs in the river gravel, the implements are generally made by chipping away one end of a suitable pebble. In other cases the stone is quarried from its outcrop, as in Victoria, from the famous aboriginal quarries of Mount William and the Charlotte Plains. The stone worked at the former is a very tough amphibolite, passing into an

impure pseudojade; at the Charlotte Plains it is a compact, tough dolerite. In other cases the stone used is quartzite, formed by the action of hot alkaline waters that have escaped from sheets of lava on underlying beds of sand.

Since the European occupation the aborigines have discovered that telegraph insulators are made of material excellently suited for the manufacture of spear-heads.

The stone implements, when necessary, are polished by being ground with water and sand. The implements, therefore, correspond to those used in Europe by the people of the neolithic stage of culture.

The implements used in the Victorian tribes are classified by A. S. Kenyon and D. L. Stirling as follows:[1]—

I. CUTTING IMPLEMENTS—
- (A) Cutting edge produced by flaking or chipping—
  1. Axes.
  2. Rasps.
  3. Knives.
  4. Adzes.
  5. Scrapers.
  6. Spear-heads.
  7. (Nuclei or Cores.)
- (B) Cutting edge produced by grinding and polishing—
  1. Axes.
  2. Wedges.
  3. Knives or scrapers.
  4. (Blanks.)

II. GRINDING IMPLEMENTS—
- (A) Kerns or mills—
  1. Nether stones with husking hole, spherical hollow.
  2. Spherical without hollow.
  3. Spherical without plane surface.
  4. Nether stones without husking hole, oval hollow.
  5. Nether (and upper) stones, circular, also used for pounding fibre.

[1] *Proc. Roy. Soc. Vict.*, n.s., xiii. 1901, pp. 191-200, pl. xxv.-xxxiii.

II. Grinding Implements—(*Continued*)—
  (A) Kerns or mills—(*Continued*)—
    6. Upper stones—
      (*a*) Spheroidal.
      (*b*) Pestle-shaped.
      (*c*) Müller-shaped.
  (B) Grinding stones—
    1. Grindstones.
    2. Whetstones.
    3. Rasps.

III. Pounding Implements—
    1. Hammers.
    2. Chipping hammers.
    3. Fibre pounders.
    4. Anvil stones.

IV. Fishing Stones.

V. Throwing Stones.

VI. Game Stones.

VII. Basket Stones.

Houses and Clothes.—The aborigines have no regular huts. They camp at night under the shelter of a lean-to bivouac, a screen made of interlaced branches. They sometimes made small bush huts or wurleys; but, as a rule, they slept out in the open, using rugs of opossum or kangaroo skins.

Clothes are conspicuous by their absence. The commonest garment is a string made of hair, worn around the waist; and from it may hang a series of tassels, which may increase in number and width till they form a small garment. A flap of skin may be hung over the shoulders. The body is generally ornamented by a series of cicatrices made by scar tattooing. The body also generally shows numerous scars, left by the deep gashes made during periods of mourning.

The aborigines are extremely skilled in using any natural material available in the manufacture of baskets, and other articles that they may require. They

make string from the hair of animals, and cords from tendons; human hair is especially useful, as it is longer and more flexible than that of any other member of the Australian fauna.

LANGUAGES.—The number of tribes, as enumerated by Howitt, is very large, but all the tribes are small in numbers, and widely scattered. Owing to their nomadic habits, any family branching off from a parent group would soon lose trace of its relatives, and having no writing to fix the language, would soon develop a fresh dialect, and form an independent tribe of its own.

The languages are all based upon the same common type, though the dialects are almost as numerous as the clans. The general languages have a complex structure: they show no resemblance to the negro languages. The general nature of the language is thus described by Barton, with especial reference to that of the Parnkalla, a tribe of the southern part of the Port Lincoln Peninsula, of whose language a grammar and dictionary was published by Schurmann in 1860. "The language," says Barton,[1] "contains no sibilants nor harsh aggregations of other consonants, and unlike many other Australian languages, notably those of Western Victoria and Swan River, includes no word that does not end in a vowel. It is, moreover, purely inflective in its verbal system; the persons, tenses, and moods of the verb being denoted by changes of termination, as in the majority of European and many Asiatic tongues. The personal endings are, in fact, abbreviated pronouns, still recognisable for such, however, as in Hebrew and Arabic, and not so obliterated as to be meaningless, as in Greek and Latin. The first personal pronoun has two forms, according as the verb with which it is joined is intransitive or transitive; the

[1] *Outlines of Australian Physiography*, 1895, pp. 168-170.

second person, besides these two, a honorific or familiar form, used both as a mark of respect and as a term of endearment. Possessive adjectives are formed with a fair degree of regularity from the pronouns. The nouns have a plural, and under conditions where it would be useful, a dual number; there are no proper cases, possession being indicated, as in Hebrew, by constructive apposition, but direction or aim by a suffix 'nga,' which can hardly be regarded as analogous to a dative case, but rather to the syllable 'ward' in such English words as 'heavenward,' 'homeward,' etc. As in the case of 'Stamboul,' and many other corrupted and misunderstood Greek local names and phrases, this syllable 'nga' has, through the ignorance of the early settlers, become wrongly incorporated in many name-places purporting to be native, such as Aldinga, Onkaparinga, Noarlunga, Willunga; their real meaning being 'towards Ngalti,' 'towards, or in the direction of, Ngaukibarri, Noarli, or Wille.' Another suffix—not a case-ending—'bidni,' indicates personal relation to, or a connection with, the thing named, *e.g.* 'Kukatarri yirrabukarri kuyabidni.' 'The Kukata (a tribe) have decayed teeth, being fish-eaters.' Literally 'fishy-folk, having to do with fish.' From 'kuya' a fish."

GOVERNMENT.—The political system of the Australians was at first described as mere primitive anarchy. The typical form of government is by a council of the men of the tribe. The councils had regular rules; and Howitt[1] tells us that they distinguished between offences against individuals, which had to be punished by the injured person, and offences against the tribe, which were punished by it. Guilt, when doubtful, was determined by ordeal, often spear-throwing. The suspected man was pelted with

[1] Howitt, *Nat. Tribes S.E. Australia*, p. 615.

spears, and if he warded them off successfully he was innocent; if not, he was proved guilty and punished at the same time.

The aborigines had no despotic chiefs as among the Maoris and the South Sea Islanders; but the south-eastern tribes had chiefs or headmen, who had considerable authority. Among the Dieri the tribal council was supreme, and the government of the tribe was democratic: all the adults or all the initiated men in the tribe had a voice and vote in tribal decisions; but even here there was a headman with well-marked authority. In Victoria there were well-established chiefs, with regular authority and position; treaties have been made with them, and they have been called "kings," such as "King Billy," the old chief of the Melbourne tribe. The chiefs were selected by the tribal council, as among the Wotjo; or the chieftainship might be hereditary to the eldest son if he were suitable, as among the Gourn-ditch-mara (Dawson).

Property and Trade.—Another asserted communistic feature in the aborigines was the absence of private ownership of property. But this view also is without foundation. Even among the Dieri each man owned his own personal effects; and there was even private ownership of land, natural products and hunting grounds. Thus the rock outcrop at Mount William (near Lancefield), from which the aborigines of Central Victoria got their chief supply of stone for their implements, was the personal property of one family. Howitt records a case in which some men stole some of the stone, and the men of the thieves' tribe promised that the theft should not happen again.

Intertribal trade was well established. Expeditions were sent out to get stones for implements, sandstones for

corn mills, red ochre and white clay for paint, wood for weapons, and fish or shell-fish. There were even regular trading stations; thus Kopperamanna was the chief market for the tribes of the Lower Cooper, and Howitt recognises in this system the beginning of the Teutonic wergeld. Trades were sometimes hereditary, especially those of medicine men and song makers; the tree climbers and canoe builders are said to be hereditary on the Herbert River in Queensland.

Intercourse between the tribes was maintained by special messengers, who were decorated to show their errand and thus secure their safety; for appointed messengers were sacred, even in distant tribes. The messenger carried a "message stick," with dots and notches cut in it to remind the man of his message. These signs were sometimes elaborate and ingenious, and, according to Howitt, some of the sticks are intelligible even if sent without a verbal message.

Religion.—The aboriginal religion is a form of fetishism; but there is much less use of material fetishes than among negroes. Magic stones and other charms were used; but, owing to the intensely vivid belief in spirits held by the aborigines, they used material symbols less often than perhaps any other people in the same stage of culture. Their powerful imaginations rendered them independent of material idols, though Howitt records a case of dancing around a life-size, clay, human image.

The whole of the life of the aborigines is governed by the belief in spirits and a spirit world. Children are said to be the incarnation of the former members of the tribe. Death is always the result of witchcraft, and disease has to be cured by the countervailing magic of the medicine man. The women and children are taught

that the noise of the bull-roarer is the voice of a great spirit.

The idea of the great spirits differs greatly in different parts of the Continent. Some of the spirits, such as the Mura-Mura of the Lake Eyre tribes, are canonised ancestors.

According to Spencer and Gillen, no moral superiority is attributed to the spirits by the Central tribes; but even among them the Kaitish believe in a spirit, the Atnatu, who is pleased by the whirling of the bull-roarer, and has some moral influence. The more advanced tribes of South-Eastern Australia believe in supernatural beings, known as Baiame, Daramulun, etc., and in an All-father, who approach nearer to the ordinary primitive conception of gods. Howitt records an image of Daramulun engraved on a tree. Howitt describes these great spirits as "anthropomorphic beings," and he is satisfied that the belief in the "All-father" is of local origin. There is no definite monotheistic worship, but Howitt believes that such might have developed from the seeds which are there.

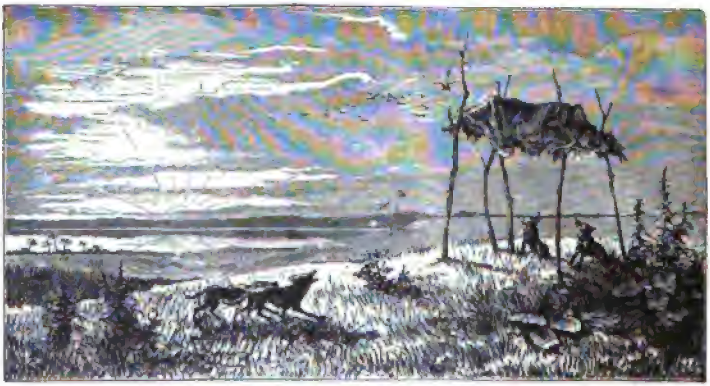
Thus the Wollunqua ceremonies described by Spencer and Gillen are said by those authors to be "a primitive form of propitiatory ceremonies." The idea of the performances is to propitiate a mythical beast, the Wollunqua.

The belief in a spirit world in the sky is widely spread. It was once, according to the Dieri, accessible from earth up three gum trees which supported the skyland. The animals of the skyland—the Kadimakara—came down to the earth to feed, and the Kutchi used to go up to the skyland for magic waters.

Many of the stars and constellations are believed to be people; Castor and Pollux are twins, Orion's belt is

a line of old women, and the Pleiades a group of young women.

Funeral Rites.—The implicit faith in spirits and a spiritual world is well illustrated by the funeral rites, which are generally elaborate and always respectful. A corpse may be buried in a well-made grave, perhaps 6 feet deep, when a soft sandhill was available; the grave was provided with food and perhaps water, and a



A BURIAL IN THE AUSTRALIAN STEPPES.

set of weapons for a man, or a yam-stick in the case of a woman.

Graves may be further protected by a stack of wood, as by the tribes along the Lower Barcoo. Other tribes do not bury, but expose the corpse, as among the Yerkla-mining. It is, however, not contemptuously thrown aside, as some negroes throw it to the hyaenas; it is placed in a comfortable position on the ground, where the relatives quietly leave it; or it may be placed in a platform made in a tree. The body may previously be embalmed by smoke, as among the Unghi; or dried in the sun and

carried about with the tribe for some time, as among the Kurnai; or it may be cremated and the ashes buried in a basket. Some of the bones or hair (as among the Kurnai) may be carefully preserved as a memento. Sometimes respect for the dead is shown by the widely spread rule of never mentioning their name.

Cannibalism as a sacrament is performed at the funerals; a morsel of flesh or of the kidney fat is eaten by the relatives, usually in order according to strict precedent. According to Howitt, cannibalism is only practised as a funeral rite, except in cases of unusual scarcity of food. But Lumholtz described it as rampant, and due to mere lust of food, among the Queensland tribes.

The funeral rites are based on the idea of making the spirit comfortable, and the cannibalism is sacramental, based on the belief that the survivors will thus inherit the virtues of the deceased.

FOLKLORE.—The folklore of the aborigines is varied and instructive. Animal stories are the most characteristic, and they show the intimate knowledge of nature possessed by the people. Some of the legends show knowledge of traditions widely spread among Caucasians. Thus a Kurnai legend, reported by Howitt, says that the Aurora-borealis was sent by Mungan the "Great Being," now in the sky, after all mankind were drowned by the rushing of the sea over the land, because the secrets of their sacred corrobory, the Jeraeil, had been revealed to the women. Lang quotes cases which resemble the myth of Isis and Osiris; and Mr. Kempe of the Peak has given me a legend of the ancestor of the Arunta, who was the son of a virgin, and who died, and after resurrection founded the Arunta tribe.[1]

[1] *The Dead Heart of Australia*, pp. 226-227.

CORROBORIES.—The corrobories are the chief social events in the life of the tribes. They are sometimes merely social festivities, for feasts and dancing; others are tribal conferences; others sacred rites to propitiate some mythical spirit beings, such as the corrobories to propitiate the Wollunqua, or to appeal to the Kadimakara, who live in the clouds and control the rain.

The boys are initiated to the secrets of manhood and take their place among the men during lengthy and elaborate initiation ceremonies, in the course of which they are taught their duties and responsibilities, and are told the secrets that are kept from the women and children.

THE CLASSIFICATION OF THE TRIBES.—The striking physical uniformity of the Australians throughout the continent renders it impossible to classify them by physical characters. It is generally agreed that there is a remarkable physical uniformity in the people all over Australia. I have been repeatedly assured by men who know the aborigines well in each of the States that it is impossible to distinguish them by physical appearances. Unfortunately, knowledge of the languages is too limited and imperfect to be of much systematic importance. The number of the tribes is legion, as can be seen by the lists given by Howitt; but the tribes are small in numbers.

The Australians may have first landed on the northern coast—either on the north-west as suggested by Eyre, or on the north-east as maintained by Mathew. The aborigines appear to have occupied the eastern half of Australia by an advance southward along three main routes—one along the eastern coast, one along the rivers running south-westward on to the Central Plains from the East Australian Highlands, and a third across the centre of the continent. From the third line people

went out westward, and may have given rise to the still imperfectly known tribes of Westralia.

The tribes of the two western lines now occupying the country from Lake Eyre northward to the Gulf of Carpentaria are divided by Spencer and Gillen into four large nations: (1) The Arunta, (2) the Warramunga, (3) the Binbinga, and (4) the Mara. These nations differ in the presence or absence of magic totemic ceremonies, the social arrangements of the totems, and the method of reckoning descent.

The south-eastern corner of Australia was apparently occupied last. The western tribes of Victoria appear to have been derived from the group with two phratries, of which the Dieri are the most typical and primitive tribe. The people of eastern Victoria have come down the eastern coast through New South Wales.

The customs of most value as clues to the migrations of the Australian tribes are those of circumcision and the knocking out of the teeth. Probably all the tribes originally removed one or two of the front teeth; they were knocked out during the initiation ceremonies by the sharp blow of a stone tool. When only one tooth was removed it was usually the left upper incisor. This rite is retained only in the eastern tribes, but traces of it occur among the rest. Thus in the people of south-western Victoria no teeth were knocked out; but a decadent form of this rite was practised among the Jajaurung, and traces of it are found among the Central aborigines.

Circumcision, and the more special rites of subincision and female incision, known as ariltha, are the most important rites among the Central aborigines. All the tribes between the Gulf of Carpentaria and Lake Eyre practise female incision.

SUBINCISION.—Subincision was widely practised either on all the men of a tribe as the Dieri (*fide* Howitt), or only on some of them, as reported by Gason. It was first reported from the Central tribes, but is found all across Australia from Queensland to the southern coast, where it was practised by the Parnkalla.

The rite of subincision was first described by Eyre. It is called the mika by Miklouko-Maclay;[1] the kulpi by Howitt;[2] the "terrible rite" by Sturt. A detailed description of this operation has been given by Professor Anderson Stuart.[3]

The object of the operation, in the opinion of most authorities, is to lessen fertility, and that it effects this purpose we have the authority of Professor Anderson Stuart. Several of the most eminent of Australian anthropologists, however, reject this explanation, on grounds which are difficult of belief, in face of the evidence quoted by Howitt[4] and Anderson Stuart, and the shape of a sacred stone named the "Generator of Snakes," given me by one of the Tirari. According to Professor Anderson Stuart, the custom may have been suggested by observation of the occasional hypospadiacs, that would be met with among the aborigines.

MARRIAGE SYSTEM.—The social organisation of the tribes is complex. It was first worked out by Howitt and Fison, whose main conclusions have been amply confirmed by the work of Spencer and Gillen.

The system is based upon the principle of exogamy.

[1] *Zeit. f. Ethnol.*, xii. 1880, v. p. 85.

[2] Howitt, A. W., "The Dieri and other Kindred Tribes of Central Australia," *Jour. Anthrop. Inst.*, xx. 1891, p. 85.

[3] T. P. Anderson Stuart, "The 'Mika' or 'Kulpi' Operation of the Australian Aboriginals," *Jour. Roy. Soc. N.S. Wales*, xxx. 1897, pp. 115-123, pl. vi.

[4] *Natives of South-Eastern Australia*, 1904, p. 262.

In its simplest form each tribe is divided, as amongst the Dieri, into two marriage castes, and no one is allowed to marry a member of the same caste. These divisions of the tribe have received various names. Howitt and Fison call them "classes," and their subdivisions "sub-classes." Spencer and Gillen call the main divisions "moieties," and the subdivisions "classes" and "sub-classes." Morgan, Frazer, Lang, Durkheim, Cunow, etc., prefer the term "phratry," and call the subdivisions, "sub-classes" or "sub-phratries."

Each phratry is divided into a number of totemic groups, which, though the origin of totemism is lost, appear to be older than the exogamic sections, for, according to a Dieri legend, the exogamic divisions were introduced to stop unrestricted intercourse between members of the same totem. Accordingly, marriage between members of the same totem was prevented by distributing the totems into two groups, and prohibiting marriage between any members of the same group. In a more advanced system, as amongst the Urabunna, to the west of Lake Eyre, not only is marriage forbidden within the phratries, but, according to Spencer and Gillen, a member of one totem may only marry a member of one particular totem in the opposite phratry. This is the two-class or two-phratry system. Some more advanced tribes are divided into four or eight sub-phratries (or classes and sub-classes), and marriage is usually prohibited between any members of each of them.

The Arunta have eight phratries, and the names of the two primary divisions of the tribe appear to have been forgotten. The complex marriage rules in this tribe have been worked out by Spencer and Gillen.

The exogamic divisions obviously prevent close interbreeding, and that the phratries were founded with this

object is affirmed by the already quoted Dieri tradition, and by evidence reported by Howitt from the Kurnai, that the object was to prevent a mixture of blood. The rules which allow a man to marry his brother's wife or his wife's sister, but prohibit the marriage of blood relations, afford further evidence consistent with this explanation.

Local exogamy—the prohibition of marriage between people of the same locality—was a simple method that would secure the same end. Thus, among the Victorian Gournditch-mara, a man was not allowed to marry into his mother's tribe, or into an adjacent group of people, or to any woman who spoke his own dialect.

The theory that exogamy was intended to stop close interbreeding is, however, necessarily rejected by Spencer, Gillen, and Roth, as a corollary of their belief that the aborigines do not regard conception as a consequence of sexual intercourse.

TOTEMISM.—The origin of the totemic groups is uncertain. There is no such obvious advantage to be gained from them as from the exogamic divisions of the tribe.

Three main suggestions of the origin of totemism have been made. According to Spencer and Gillen, and Frazer, the object is to make one group of individuals in a tribe responsible—by the performance of magic ceremonies known as *intichiuma*—for the provision of an adequate supply of any particular food. Thus, according to Spencer and Gillen (*Northern Tribes*, p. 327), "The fundamental idea, common to all of the tribes, is that men of any totemic group are responsible for the maintenance of the supply of the animal or plant which gives its name to the group, and that the one object of increasing the number of the totemic animal or plant is simply that

of increasing the general food-supply." Thus the members of the rain totem have to call down rain, the members of the emu totem have to maintain an adequate supply of emu eggs, feathers, and meat for the other members of the tribe. Accordingly, the emu man may kill emus but he may not eat them. But in Victoria, and elsewhere, a man may eat his totem as well as kill it (*e.g.* Howitt, p. 145).

The tribes of the area investigated by Spencer and Gillen have no particular friendship for their totems, and do not show the grief and remorse shown, according to Sir George Grey, by the aborigines of the north-western coast of Westralia when one of them chances to kill his own totem.

The second theory regards the totems as having arisen from the association, imaginary or accidental, of some members of a tribe with a particular animal or food. "The lives of bats are the lives of men" is a saying in one tribe reported by Howitt. The people had such a firm belief in spirits and in the transmigration of spirits, that it is easy to understand how some members of a tribe might be considered to have some connection to some particular animal. According to Howitt, the association probably arose through dreams; according to Haddon, probably owing to some connection with the food supply.

A third series of suggestions is based on the idea that the totemic groups are old clan or race divisions, and that they have been due to the fusion of independent groups of people. This view is advocated by Andrew Lang, and according to him the totemic names are nicknames. He suggests that a tribe living beside a water-hole, and living mainly on the produce of its fish-traps, might be nicknamed "fish" by the people

living on the adjacent plateau; the hunting aborigines, who lived on the plateau and fed on snakes, mammals, or insects, and did not despise any dead creatures they might find, might be nicknamed "crows," owing to their carrion diet, by the fish-eating people. At some period there might be a water-famine and drought on the plateau; and the plateau aborigines, the crows, might be driven to the valley, and settle beside the fishermen. The two groups would then learn their nicknames, and might retain them; and thus the settlement would have its two constituents marked off by the names which they had previously given one another.

This theory agrees with that of J. Mathew, who, in his *Eaglehawk and Crow*, maintains that the two sections of the Australian tribes thus named were originally distinct races that have fused.

Cunow also considers that the phratries were racial in origin, but he regards the phratry as essentially different from a class. He thinks that the phratry was formed by the amalgamation of peoples, and the classes were age distinctions.[1]

That the totemic groups arose earlier than the phratries is universally admitted; and the balance of opinion is in favour of the view that marriage was prohibited within a totem before the foundation of the phratries. This latter view is inconsistent with the Dieri legend already quoted, and Lang dissents from it. He ridicules the idea of the deliberate bisection of a tribe for the sake of controlling the food-supply or natural enemies; for the tribes would not then have been divided into only two groups. The division of a tribe into two, the ravens and the wolves—one part of the tribe having

[1] *Die Verwandtschafts-Organisationen der Australneger*, Stuttgart, 1894.

to propagate ravens, and all the rest having to propitiate wolves—would leave most of the essential work of the tribe unprovided for.

Group Marriage.—The elaborate marriage rules of the aborigines were quite unknown to the settlers, who reported that the aborigines had no marriage system, and practised indiscriminate, unregulated sexual intercourse. The basis of this view was, perhaps, the system of group marriage, which still survives, according to Spencer and Gillen, among the most primitive tribes of Lake Eyre. Thus they state:[1]—

"Individual marriage does not exist either in name or in practice amongst the Urabunna tribe. In this tribe we have:—

"(1) A group of men all of whom belong to one moiety of the tribe and are regarded as the *nupas*, or possible husbands, of a group of women who belong to the other moiety of the tribe.

"(2) One or more women specially allotted to one particular man, each standing in the relationship of *nupa* to the other, but no man having exclusive right to any one woman—only a preferential right.

"(3) A group of men who stand in the relationship of *piraungaru* to a group of women, selected from amongst those to whom they are *nupa*. In other words, a group of women of one designation have, normally and actually, marital relations with a group of men of another designation."

The Dieri on the other side of Lake Eyre had a similar system:—

Each man had one particular wife, his *nupa*, who could only act as another man's concubine, or *piraungaru*, in her husband's absence. On special occasions, however,

[1] *Northern Tribes of Central Australia*, p. 73.

a man had the right of access to any woman whom he might legally have married; or the rules of taboo might be relaxed in regard to a woman at her marriage; and on great occasions the marriage rules may have been suspended in regard to all the women. The survival of group marriage is, however, very rare. Among the Wotjobalak of Victoria the marriage was individual, but a woman could be lent by a husband to another man (Howitt, p. 245). In another Victorian tribe, the Gournditch-mara, we find a still stronger step upward in the moral scale. Though wives may be lent, this act, according to Howitt, was regarded as discreditable, and the man who was guilty of it was attacked by the other members of the tribe.

Lang regards the cases of group marriage, not as primitive survivals, but as a special development, due to the suspension of ordinary marriage relations, to various degrees, on various occasions.

This authorised license was accompanied by extreme severity towards any breach of the rules of morality. Death was the probable penalty to a man who had been found guilty of sexual intercourse with a woman whom he could not lawfully have married. Even the marriage of people within prohibited degrees by mistake or ignorance is said to have been a capital offence.

VARIABILITY OF THE MARRIAGE RULES.—The exogamic rules are easily intelligible in their simplest form, but in practice they appear to be very complex, as they are not rigidly followed; their original simplicity is obscured by a fog of exceptions and deliberate changes. Among the Dieri, Urabunna, and Warramunga, the two phratries are the dominant divisions; but among the Arunta, the two primary divisions have no names, though there are names for the four exogamic divisions of

the Southern Arunta, and the eight in the Northern Arunta.

The eight-fold division of the tribe is probably the most specialised form known in Australia; but it is so complex that it is of doubtful stability, and a man, according to Howitt, may marry into both sub-phratries of the opposite phratry, which is a practical return to the two-phratry system (Howitt, p. 212).

Even the fundamental rules that forbade marriage among members of the same phratry or totem are broken; thus, the Kamilaroi allow marriage in the same phratry, provided the pair belong to different totems; while the Arunta allow marriage between members of the same totem. While in the south-eastern corner of Australia there are only faint traces of totems, and marriageability was determined by localities. Thus, Thomas records the fact that a Melbourne native had to marry a woman from one of five tribes; and Howitt gives a table of the reciprocal marriage localities among the Kurnai.

The totem may be inherited from the mother, from the father, or it may not be hereditary, but derived from the locality where the spirit, of which the child is the reincarnation, entered the mother.

These changes are not always a slow, unconscious growth; according to Spencer and Gillen, and to Howitt, they are made deliberately, as shown by the following extract from Spencer and Gillen: "This *deliberate changing* of the method of grouping the sub-classes so as to allow of descent being counted in the female, the indirect male, or, we can now add, the more direct male line, according to the necessity of the case."[1]

[1] *Northern Tribes of Central Australia*, p. 123.

2. Relative Primitive Position of the Australian Aborigines

The view that the Australian aborigines are the most archaic of mankind has no adequate evidence in its support, and is *a priori* improbable. It is almost certain that mankind was not first developed in Australia. "Our progenitors," said Darwin, "inhabited the Old World, but not Australia nor any oceanic island, as we may infer from the laws of geographical distribution. . . . It is somewhat more probable that our early progenitors lived on the African continent than elsewhere."[1] Moreover, it is equally probable that man evolved under geographical conditions very different from those of Australia. He must have developed in a land inhabited by anthropoid apes, and doubtless in a forest land. The passage from his original home to the open plains of Australia involved an extreme change in the conditions of life. The occupation of the arid regions of Australia by man has only been possible by his adaptation to an extremely altered environment, and the adoption of special habits of life.

The characters of the Australians, physically and socially, show abnormal specialisation to suit their abnormal geographical conditions. Nor is there any direct evidence of the special antiquity of man in Australia. I have recently discussed the available evidence for Victoria:[2] in that State, excluding the far eastern province, Croajingolong, the gravels and drifts have been searched for gold with extraordinary thoroughness; but no authenticated trace of man has been found except in very recent deposits. The old surfaces of the sand

[1] Darwin, *Descent of Man*, 2nd edit. p. 155.

[2] "The Antiquity of Man in Victoria," *Proc. R. Soc. Vict.* (new ser.) vol. xvii. 1904, pp. 120-144.

dunes on the coast are well exposed, and old land surfaces in the gold-bearing gravels; but traces of man and his stone implements are only known from the recent surfaces. The author estimated that nothing has yet been discovered which proves the human occupation of Victoria for more than perhaps 1000 or 1500 years.[1]

Buried implements have been found in Queensland which may indicate a much greater antiquity, but the evidence is still inadequate. Etheridge has pointed out the absence of any proof of the antiquity of man in Queensland and New South Wales. The most important buried trace of man in New South Wales is that described by Etheridge, David, and Grimshaw[2] from Shea's Creek, near Sydney; but it gives no proof of any considerable age.

There is nothing, so far as is known, in Australia which indicates for man so great an antiquity as has been proved in Africa, Europe, Southern Asia, and America.

Literature on the Aborigines.

The literature has been catalogued in a valuable "Bibliography of the Australian Aborigines," by R. Etheridge, junr., of which three parts have been published in the *Mem. Geol. Survey*, New South Wales, 1890, 1891, and 1895.

Among recent literature the most important are Spencer and Gillen, *The Native Tribes of Central Australia*, and *The Northern Tribes of Central Australia* (1904); and A. W. Howitt, *The Native Tribes of South-Eastern Australia* (1904). Therein Howitt gives reference to the important works and memoirs by himself and Fison, which first placed our knowledge of the customs of the aborigines on a satisfactory basis. Roth is the main authority on the Queensland aborigines.

Amongst other recent literature are the following:—

Lang's theory of the origin of totemism, with abundant reference to

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[1] This estimate is given, in spite of a geologist's constitutional abhorrence of expressing geological time in years, to illustrate approximately the recent date of the oldest established traces of man in Victoria.

[2] *Journ. R. Soc. N.S. Wales*, xxx. 1897, p. 179. The authors say that the age cannot be earlier than Post-Tertiary, and cannot be Pleistocene.

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3. The Aborigines of Tasmania

The Tasmanian aborigines have been often described as the most degraded and lowest race of mankind which has lived in modern times. The description is perhaps not unjust. The affinities of the race have been the subject of long discussion, and very different conclusions have been formed. Thus they have been regarded as negroes, as by Fitzroy (1839); as Australians with the hair of Papuans, by Giglioli (1874); as an unaltered, isolated remnant of the Australian race, as by Roth (1890), and Howitt (1904); as Negritoes, as by Pritchard (1847), Huxley (1870), E. M. Curr (1886); and as a primitive race of Melanesians, as by Flower (1885), who described them as "pure, but aberrant members of the Melanesian group, altered by long isolation; a cross with any Polynesian or Malay races would have left traces on the general organisation which cannot be discerned."

The fullest and best summary of the available information about the Tasmanian aborigines is in the *Aborigines of Tasmania*, by H. Ling Roth.[1] The race is now extinct, and in number it was probably always small; the estimated population has, indeed, been put as high as 20,000,[2] but this number is generally scouted; and the general opinion favours such estimates as those of Milligan, who put it at not more than 2000, or of Backhouse,[3] whose estimate was 700 to 1000.

The Tasmanians were divided into four main groups, each of which spoke a different dialect. These groups

[1] *The Aborigines of Tasmania*, by H. Ling Roth, assisted by Marion E. Butler and James Backhouse Walker, with a chapter on the Osteology by J. G. Garson. 1st edition, 1890; 2nd edition, 1899. Halifax, small 4to, pp. xx, 228, and ciii, with map and 16 pl.

[2] Melville, *Australia and Prison Discipline*, 1851, p. 345.

[3] *Narrative of a Visit to the Australian Colonies*, 1843, p. 79.

were subdivided into so-called tribes, which were associations of families, and are sometimes, and more justly, called "mobs." Each of them included from about 30 to 200 individuals.

The dialects have been described as so different that they have been ranked as separate languages; but, according to Latham,[1] "The Tasmanian language is fundamentally the same for the whole island, although spoken in not less than four dialects, mutually unintelligible."

The thirteen available glossaries have been reprinted by Roth,[2] according to whom the language "is not only distinctly non-Papuan, but it has Andamanese characters."

The physical features of the Tasmanians are well defined. The colour of the skin is described as dull black or bluish black, instead of the chocolate brown of the Australian. The head has a high, prominent forehead and prominent malar bones; the eyes are small and sunken; the nose is flat and broad; the mouth is wide and large, and generally has thick lips; the teeth are large and strong, and they are set in massive, prominent jaws. The body is well proportioned and muscular, but the limbs were thin. The height of adults ranged from 5 feet 3 inches to over 6 feet; the average height of twenty-three individuals measured by G. A. Robinson was 1618 mm. (5 feet $3\frac{7}{10}$ inches). The skeleton in the Natural History Museum is 1635 mm. (5 feet $4\frac{1}{3}$ inches).

The skeleton has been described in detail by Garson. His account states that "The characters of the cranium may be summed up as follows: globular in form, subdolichocephalic, without notable transverse depression as

[1] In J. B. Jukes' *Voyage of the Fly*, 1847, p. 319.

[2] Roth, Appendix, pp. i-lxxxiii.

to the rise of forehead, broadening rapidly from before backwards, with rounded sides and large conical parietal bosses. The frontal crest is absent, but a characteristic disposition of the vault, termed *keeled*, is present. The posterior parietal region is receding.

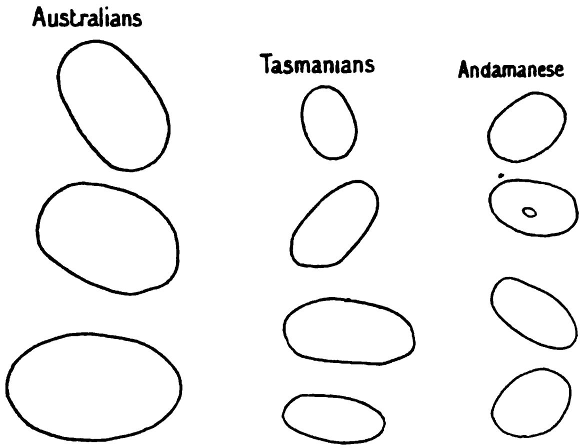
"The facial portion of the skull is as characteristic as the cranium. The first thing which strikes one is the wild and sinister appearance which invests the whole physiognomy, and which may be attributed to the depth of the orbits and the form of the notch of the nose. These peculiarities are due firstly to an excessive development of all the facial portion of the frontal bone, and secondly, to a backward recession *en bloc* of the superior maxilla, the curve of the frontal bone being prolonged downwards to meet the nasal bones at their inferior and anterior extremity.[1]

"The face is characteristic not on account of size, which is not exceptional, but owing to its shortness and particularly brutal appearance.[2] The malar bones are depressed at their superior angles. The nose is of moderate length, but very broad, and is deeply pressed in at the root. The nasal bones proper are concave in profile, somewhat flattened, very convex, and pinched together (especially above the ascending branches of the maxillæ which support them), and are alternately concave and convex from above downwards, and from without inwards. The inferior border of the nasal opening is rounded and elevated in the middle line. The nasal spine is double. The orbital openings are horizontal and of elongated square form. The canine fossæ are deep, and the anterior alveoli are visible on the surface of the dentary arch as large rounded swellings.

[1] Garson in H. L. Roth, *Aborigines of Tasmania*, p. 197.

[2] *Ibid.* p. 200.

"The prognathism is moderate, and affects the whole face, but is not very marked in the sub-nasal region. The disposition of parts resembles that found in the Mintiras, a true Negrito race. The prominence of the lower part of the forehead is considerable, so that the facial angle, measured by taking the supra-orbital point as the upper end of the facial line, attains 75°, although



THE SHAPE OF TRANSVERSE SECTIONS OF THE HAIR OF AUSTRALIANS, TASMANIANS, AND ANDAMAN ISLANDERS (AFTER HICKSON).

the upper jaw taken by itself shows a projection corresponding to a very much smaller angle. The alveolar angle is 66°, and the dentary angle is 59°."

The characters of the hair have been described by Pruner Bey and Hickson. The hairs are fine, and in transverse section their shape is a flattened ellipse. According to Pruner the ratio of width to thickness is as 25 is to 15. The shape of sections of the hair of Australians, Papuans, and Tasmanians is shown above. Owing to the flattened shape of the hair, it was curly

and had a well-marked spiral twist. It has been described as growing "in small corkscrew ringlets," like those of the South African Bushmen. But unlike negroes, the Tasmanians had no marked deficiency of hair, the breast and back being covered by down. The hair was woolly; according to Furneaux it was "as woolly as that of any native of Guinea," but according to Davies it was less woolly than that of negroes. The colour of the hair has been usually described as being black, except when bleached by lime in the clay plastered on it in periods of mourning. But Hickson describes the hair as of a light golden-brown colour. He says:[1] "Comparing it with the hair of other races, I find that it is lighter in colour than the hair of the Andamanese, which is of a rich brown colour; of the Papuans of the south coast (New Guinea), which is of a dark-brown to almost black colour; or of the Australians, which is quite black.

"The curliness of the hair of the Tasmanians is less than that of any of the Papuans or Andamanese, but more than that of the Australians. Thus the average diameter of the curl of the Andamanese is 2 mm., of the Papuan 3 mm., but in the curliest hair of the Australians the curls are 10 mm. in diameter, and the average must be nearly 15 mm.

"As to flatness. The hairs of the Tasmanian and Andamanese are much flatter than those of the Australian and Papuan. The hair of the Papuan is flatter than that of the Australian, but is remarkably round for a curly-headed race. This applies only to the Papuans of the South Coast (New Guinea). The hair of the Papuans investigated by Pruner Bey seems to have been much flatter. The hair of the Tasmanians is finer than the

[1] S. J. Hickson in Ling Roth, *op. cit.*, 2nd edition.

hair of the Papuans and Australians, but not so fine as the hair of the Andamanese."

The mental characters of the Tasmanians have been very differently described. Our knowledge of the subject is unfortunately meagre. Indeed, Spencer and Gillen declare [1] that "Of his beliefs and customs it may be said, that we know nothing whatever of any real value." They have been described by some observers as mentally primitive, and by others as very intelligent and clever. Thus, on the one hand, Mrs. Prinsep [2] says, "They are undoubtedly in the lowest possible scale of human nature, both in form and intellect"; but, on the other hand, Calder [3] says, "It has been customary to rank the Tasmanian savages with the most degraded of the human family, and as possessed of inferior intelligence only. But facts quite disprove this idea, and show that they were naturally very intellectual, highly susceptible of culture, and, above all, most desirous of receiving instruction, which is fatal to the dogma of their incapacity for civilisation." Bonwick, formerly a Government Inspector of Schools, reports that, "When I saw the aboriginal boys and girls in the Orphan School, near Hobart Town, I inquired of their teacher in what respect they differed from the children of the convicts among whom they were thrown. All of the white race were very inferior in point of *physique* and intellect to others of their age and colour, of different parentage. They were, however, superior to the dark children in facility of learning arithmetic and grammar, though not so in geography, history, and writing. Two of the coloured lads readily and cheerfully answered my

[1] Spencer and Gillen, *Northern Tribes of Central Australia*, p. 16.
[2] *Voyage to Van Diemen's Land*, p. 79.
[3] *Journ. Anthrop. Inst.* vol. iii. (1874), p. 19.

questions in geography, and indicated places on the map with great correctness." Walker speaks[1] of an aboriginal boy at the Orphan School at Hobart, "who writes a very fair hand for any lad of his age. The master informs me that, with some exceptions, these aboriginal children are not inferior in capacity to European children." Backhouse[2] says, "After having seen something of the natives of Van Diemen's Land, the conviction was forced upon my mind that they exceeded Europeans in skill in those things to which their attention had been directed from childhood."

The religious system was a form of fetishism. There appears to have been a firm belief in spirits. Corrobories were held, but these, so far as is known, were mainly for dancing and amusement; they were held at full moon, probably on account of the light. "Nothing is known concerning any initiatory rites practised by the Tasmanians," says Roth (*op. cit.* p. 115), but they had a threefold system of tabu. Cannibalism does not appear to have been practised.

In burial, according to Peron, the bodies were burned, and the ashes buried under a conical hut of bark strips.

Arts were at a low ebb. The Tasmanians had no agriculture, and no domestic animals. They had numerals, at least up to five.

Fire was obtained by friction, either by the rotation of a fire-stick, or by friction in a groove; but in so wet a climate this method of getting fire presented unusual difficulties, and lighted fire-sticks were carried from camp to camp. The usual camp was under the shelter of lean-to bivouacs made of screens; but there is a general agreement that they also had thatched beehive-

[1] *MS. Journ.*, May 28, 1834.
[2] *Visit to Australian Colonies*, pp. 173-174.

shaped huts, as at Macquarie Harbour, on the West Coast (Roth, p. 109). Bonwick says that they originally used huts, but abandoned them when the war with the Government began, and they were driven to a nomadic life.

The Tasmanians were naked, only wearing skins over the shoulders in severe weather. For ornament they wore necklaces of shells.

They made baskets of twisted fibres and reeds.

The stone tools were rude, unground, roughly-chipped implements, made of a metamorphic mudstone or hornstone, obtained either from pebbles in the river gravels, or quarried from its outcrop. The stone tools were never used in handles, and were never polished or ground like those of Australia, whence the few ground implements found in Tasmania were derived. The usual implements had one flat side, chipped away at the edge to make a cutting edge. They were used for cutting and scraping wood for spears, and fire-sticks; for scraping skins and skinning kangaroos, and cutting notches in the bark of trees, so that the high, straight stems of the gums could be climbed in pursuit of opossums.

The boats of the Tasmanians were primitive catamarans, made of three bundles of bark tied together. In describing one rude craft found on the western shore of Adventure Bay, Rossel, who was La Billardière's companion, says it was composed of three bundles of bark tied together. Freycinet's account of the craft is that it was 9 ft. 8 in. in length inside, 2 ft. 11 in. broad, 1 ft. 3½ in. high, 8½ in. deep inside; thickness at the ends, 10½ in. They could carry five or six men, but usually carried three or four. They were rowed by sticks or bark paddles, and, according to Bonwick, would go as quickly as a whale-boat, and they would live in very rough seas;

and he mentions a case of one of them crossing to Witch's Island in a storm. Moreover, the aborigines were living on Hummock Island at the time of Flinders' visit; so they must have been able to cross Banks' Strait; and they also crossed from the mainland to Hunter's Island, north of Cape Grim.

A model of one of these catamarans, brought back by Sir John Franklin, is now in the University Museum, Oxford.

In spite of the limited and often unreliable contemporary information about the Tasmanians, the evidence is sufficient to indicate their general affinities. Garson[1] points out that though the race, from its geographical position, might be expected to be allied to the Australians, "many points in the morphological characters of the two races are so totally unlike as to render this relationship problematical." On the other hand, he says their geographical position, on an outlier of the Australian continent, naturally led to the view that they were probably an outlier of the Australian race. That they were not simple Australians was pointed out by Topinard in 1871, and is clearly shown by the characters of their hair. Garson, *e.g.*, says the morphological characters of the two races are "totally unlike." Hence Flower, in 1878, suggested that the Tasmanians were Negritos who had once occupied Australia, where they have been exterminated by the existing Australian aborigines. This view has been accepted by Howitt and Roth. Roth recognises "a possible likeness" between Australian and Tasmanian customs; but the resemblances he quotes, the corrobories, "the curious structures, fire legends, ants reviving dead people, the use of a separate fire by each family, and the alleged use of moccasins, the

[1] In Roth, *op. cit.* p. 212.

latter possibly the same as the feather-tracking shoes of the Australians,"[1] are meagre and inadequate to prove any connection between the two peoples. Huxley, in 1870, declared that it seemed "physically impossible that the Tasmanian could have come from Australia, and apparently the only way for accounting for the presence of the Tasmanian was to assume his migration from New Caledonia and the neighbouring islands." And he suggested that the ancestors of the Tasmanians arrived along a chain of islands, now submerged, that connected New Caledonia and Tasmania."

That the Tasmanians are Negritos has been maintained repeatedly, and there is much evidence in its support. Thus, according to Garson, "in some respects the Tasmanians resemble very closely the Negrito race, not only in the character of the hair, but in some of their osteological characters." "From the osteological character and those of the hair, skin, etc., it appears as if the Tasmanians were most allied to the Negrito and Melanesian types. In any case, the Tasmanians have remained for a long period isolated from other races, as evidenced by the uniformity of their osteological characters." Huxley definitely included[2] the Tasmanians in the Negritos. "The best known and most typical of these eastern Negritos," he said, "are the inhabitants of Tasmania and New Caledonia."

By what route the Tasmanians travelled is doubtful. Resemblances between their stone implements and some found in parts of Westralia might suggest a possible migration from the Andaman Islands around the

[1] T. H. Huxley, in discussion on paper by James Bonwick "On the Origin of the Tasmanians," *Journ. Ethnol. Soc.* vol. ii. (1870), p. 131.

[2] Huxley, "On the Geographical Distribution of the Chief Modifications of Mankind," *Journ. Ethnol. Soc.* vol. ii. (1870), p. 404.

western and southern coasts of Australia. Indeed, R. H. Davis (1846) held that the aborigines reached Tasmania from King George's Sound. But the view that the Westralian implements are similar to those of Tasmania has not been confirmed. The general evidence suggests that the Tasmanians travelled down the eastern side of Australia, which once extended far out into the Tasman Sea. There is good geological evidence that part of this land has foundered beneath the sea in times which are geologically recent. The Tasmanians were shore dwellers, and expert swimmers, and skilful in the management of their catamarans, even going to sea in them in the face of storms. Hence the absence of evidence of the former existence of the Tasmanians on the mainland of Australia may show, in time, that Latham and Huxley[1] were right in their belief, that the Tasmanians reached Tasmania from Melanesia along the shores of lands that once lay off Eastern Australia.

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[1] Huxley, *Journ. Ethnol. Soc.* vol. ii. (1870) p. 131.

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CHAPTER IX

THE MURRAY RIVER

THE Murray is the one great river of Australia, and its length, which to the uppermost source of the Condamine is some 3800 miles, and the area of its basin, 414,253 square miles, should entitle it to rank as one of the great rivers of the world. Its basin is double the area of France. It includes nearly one-seventh of the total of 2,950,000 square miles in the Australian continent. The river drains five-sixths of New South Wales, considerably more than half of Victoria, over 100,000 square miles of Queensland, and 24,000 square miles of South Australia. But the volume of its water and its economic value do not correspond to the size of its basin. It receives the drainage of 1000 miles of mountainous country, which has a considerable rainfall. But the Murray sometimes has no discharge whatever to the sea.

The comparatively small volume of the Murray is due to the fact that most of its course lies through low-lying plains, where the rainfall is far less than the rate of annual evaporation; so that the plains take more from the river than they add to it, and they only contribute to it the water that runs off in heavy storms. Only 158,499 square miles of the area in its basin make any effective contribution to the volume of the river. The

remaining 255,754 square miles consist of flat alluvial areas that absorb the rainfall they receive. According to the Report of the Inter-State Commission on the Murray (1903),[1] the effective catchment is, in

	Square Miles.
Queensland	67,690
New South Wales	75,499
Victoria	15,310
Total	158,499

and the total non-contributing areas in the four States are—

	Square Miles.
Queensland	36,835
New South Wales	158,863
Victoria	35,669
South Australia	24,387
Total	255,754
Grand Total	414,253

The Murray River rises in a series of streams which drain the western slopes of the highlands of Southern Queensland and New South Wales, and the northern slope of the Victorian Highlands. It is a compound river, formed by the engrafting of three distinct rivers, the Darling, the Murrumbidgee, and the Hume or Upper Murray, on to one trunk, the Lower Murray. These

[1] The main sources of information on the Murray are in the Reports of Parliamentary Commissions by South Australia and Victoria, notably in the Inter-State Commission Report of 1903. Also on the Reports on River Gauging, by the Water Supply Branch of the Mines Department of Victoria. A very useful general summary is given in a lecture to the Sydney University Engineering Society by R. T. M'Kay, *The Murray River, Irrigation and Navigation* (Sydney, 1903, 68 pp. 2 maps, illustrations). An account of the scenery on the Murray, with excellent views, are given in A. S. Murray's *A Thousand Miles on the River Murray.*

three rivers once entered independently into an inland sea which ran northward from Encounter Bay.[1]

The name of the Murray was given to the river by Sturt, but the main upper stream had previously been called the Hume. It has been often proposed to re-

Photo. *J. W. Gregory.*

THE UPPER MURRAY (OR HUME), IN EASTERN VICTORIA, NEAR COBRAM.
With Red Gum Forests.

introduce that name, as it has the prior claim. This change is now practically impossible. But it might be possible, and would be convenient, to retain the name Murray for the lower main trunk, to which Sturt applied it, and to call the Upper Murray by its original name of the Hume.

[1] *Geography of Victoria*, pp. 120-121.

The head-streams of all three rivers flow at first through deep gorges cut back into the Highlands, such as the Gates of the Murray, well known from Kingsley's description in *Geoffrey Hamlin*, and the precipitous gorges in the Liverpool Plains and the New England Plateau. Many of the head-streams of the Murray rise at no great distance from the Pacific coast. The sources of the Condamine are about 80 miles from the Queensland coast, but their waters reach the Southern Ocean after a course of about 3800 miles. The nearest source to the Pacific is the Eumerella branch of the Murrumbidgee, a fact which has given rise to some controversy as to the boundary between Victoria and New South Wales. The boundary was defined as a line from Cape Howe to the nearest tributary of the Murray River. It has been claimed,[1] *e.g.* by Ogier, that the line from Cape Howe to the Eumerella is the legal frontier, and that therefore all the Riverina was intended to belong to Victoria. The fallacy in this argument is that the Act clearly intended a tributary of what has always been regarded as the main stream of the Murray, in contradistinction to a tributary of any of its tributaries. The Act did not say, and clearly did not mean, a line from Cape Howe to the nearest tributary of the Murrumbidgee. The meaning of the Act is shown by its distinct inclusion of the Riverina in New South Wales.

When the Murray and its head-streams leave the highlands of Eastern Australia they often flow on flood plains raised above the level of the surrounding country. Thus Yarrawonga, on the banks of the Murray, is 6 feet higher than Telford, 7 miles away from it; Wahgunyah

[1] J. C. H. Ogier. *The Question of Original Official Boundary between the States of New South Wales and Victoria.* Melbourne, 1902. 10 pp. and map.

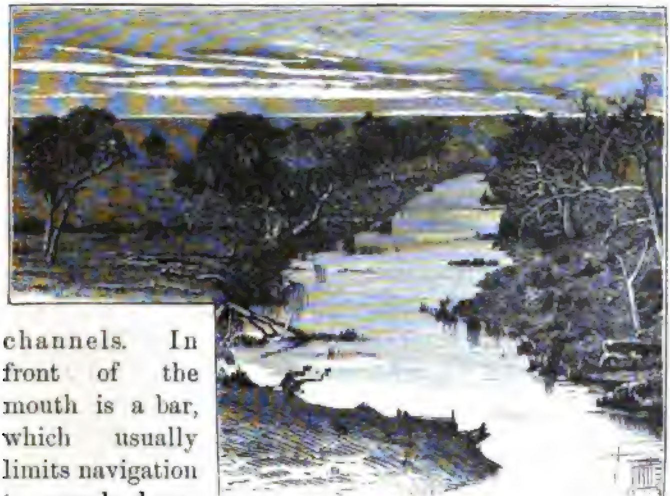
is 6 feet higher than Lilliput, 9 miles to the south; and Cobram, on the Murray, is 23 feet higher than Numurkah on the southern border of the Murray Plains. The existence of this raised flood plain forces some of the tributary streams to flow parallel to the Murray for great distances before they can join it; thus Back Creek and Border Creek flow parallel to the Murray until it sweeps southward at right angles to its main course, and thus collects this tributary and the Goulburn. Further west, along the Murray and the Darling, the rivers that drain the slopes of the valley fail to reach the main river, and they spread out in shallow lakes at the foot of the raised flood plain. Frequent deviations occur in the course of the river, in consequence of the floods breaking through the raised flood plain and forming a new channel along the lower ground. The two channels thus caused may for a time both remain in existence, or both may be used in floods. Thus the Edwards River leaves the Murray near Cobram, and after a long course through the Riverina is forced back into the Murray by the raised banks of the Murrumbidgee.

Such anastomosing branches of the river are called anabranches, a term of English origin, which has been retained in use in Australia often apparently under the impression that it is an aboriginal term. The lakes left in the cut-off meanders of the Murray are called billabongs, and they are especially numerous in all stages of infilling on the south side of the Murray near Rutherglen.[1]

The Murray discharges into the vast lagoon known as Lakes Alexandrina and Albert, which are separated from the sea by a long line of sandbanks known as the Younghusband Peninsula. This peninsula extends over 70 miles in length, and its width is sometimes only about

[1] Mapped by Norman Taylor, *Geol. Surv. Vict.*, Sh. 81 N.W., and part reproduced in Gregory, *Geography of Victoria*, p. 155.

half a mile. Behind it is a long, narrow lagoon known as the Coorong, the width of which varies up to about 3 miles, and on an average is about 2 miles wide. The Coorong runs south-east along the shore of Encounter Bay. At the north-western end of the Younghusband Peninsula the surplus water from Lake Alexandrina is discharged to the sea, through an aperture known as the Murray mouth. The water reaches this outlet by four



CURRENCY CREEK, LAKE ALEXANDRINA, ON THE RIVER MURRAY.

channels. In front of the mouth is a bar, which usually limits navigation to vessels drawing not more than about 7 feet.

The rainfall for the whole Murray basin averages 13 inches a year; but the main supply of water is collected in the Upper Murray basin, which has a mean rainfall of 40 inches. The most useful contribution is given by the melting of the snow on the Australian Alps in spring and early summer. Owing to the large contribution of the Upper Murray, it is often stated that Victoria contributes

far more to the Murray than New South Wales; but this idea is disproved by the detailed river gaugings of the Victorian Water Supply Department, which are among the finest contributions to scientific geography yet made in Australia.

The actual contribution to the volume of the Murray during a series of years is as follows:—

	High Year. Cubic Feet.	Mean Year. Cubic Feet.	Low Year. Cubic Feet.
New South Wales contribution	1,010,000,000,000	424,000,000,000	293,000,000,000
Victorian contribution .	446,000,000,000	255,000,000,000	153,000,000,000
Proportion of the total contributed by Victoria .	29 per cent	37 per cent	34 per cent

The Murrumbidgee ranks next to the Murray in regularity of flow and discharge. The Darling is the longest of the three constituents of the Murray; its highest tributary is the Condamine; the next section is known as the Macintyre, which continues as the Barwon as far as Bourke, below which it is known as the Darling. The gentle fall of the Murray and the Darling is shown by the following table:—

Fall of the Murray River

Between Wentworth and Euston the fall is $3\frac{3}{4}''$ per mile.
Between Euston and Moama-Echuca the fall is $4\frac{1}{4}''$ per mile.
Between Moama-Echuca and Tuppal Creek the fall is $7\frac{1}{4}''$ per mile.
And from Tuppal Creek to Albury the fall is 9″ per mile.

Murrumbidgee

From Murray River Junction to Balranald the fall is 5″ per mile.
From Balranald to Hay the fall is $5\frac{1}{2}''$ per mile.
From Hay to Narrandera the fall is 10″ per mile.
From Narrandera to Wagga-Wagga the fall is 10″ per mile.
From Wagga-Wagga to Gundagai the fall is $16\frac{1}{4}''$ per mile.

The rate of evaporation in the Murray basin is high, and the maximum may be taken at 60 inches a year, against a mean rainfall of 13 inches. Hence the Murray at Mildura only discharges 7·57 per cent of the available rainfall above that point; and according to a famous calculation by Mr. H. C. Russell, the Darling was considered to discharge an even lower proportion.

The enormous leakage and loss of water from the Murray is shown by the following statistics for the year 1900, taken as a representative average year:—

At Albury the total natural discharge of the Murray and its tributaries should have been 162,000 million cubic feet; the actual discharge was 144,000 million cubic feet, showing a loss of 18,000 million cubic feet. At Echuca the total natural discharge should have been 313,000 million cubic feet, and the actual discharge was 254,000 million cubic feet. The loss between Albury and Echuca was therefore 41,000 million cubic feet. At Tooleybuc the natural total discharge should have been 328,000 million cubic feet; the actual discharge was 208,000 million cubic feet. The loss between Echuca and Tooleybuc was therefore 61,000 million cubic feet. At Mildura the total natural discharge should have been 531,000 million cubic feet; the actual discharge was 371,000 million cubic feet, so the loss between Tooleybuc and Mildura was 40,000 million cubic feet. At Morgan the natural discharge should have been 679,000 million cubic feet, and the actual discharge was 455,000 million cubic feet. The loss between Mildura and Morgan was therefore 64,000 million cubic feet.

The navigation of the Murray[1] was begun in 1853

[1] A digest of the history of navigation on the Murray is given in the "Progress Report of the Commission on the Utilisation of the River Murray Waters," *Parl. Papers S. Australia*, 1890, No. 34, pp. 40-44.

by Captain Francis Cadell in the steamer *Lady Augusta*, a 72-ton vessel, which was taken through the mouth. Captain Randell began trading on the river in the same year. Cadell reached Albury, 1468 miles from the mouth of the Murray, in 1854. Having thus shown the practicability of navigation on the river, he put on two additional steamers to ply on the Upper Murray, Murrumbidgee, and the Darling for three years, in consideration of a subsidy of £4000 from the South Australian Government. Navigation in mean seasons is practicable as far as Albury; but the steamer trade, except for barges bringing down wool and timber, is unimportant below Echuca, which is 666 miles from the South Australian border. On the Darling steamers trade as far as Walgett, 1180 miles from Wentworth. The Murrumbidgee is navigable to Hay.

The first difficulty in opening the river to trade is its narrow, sand-barred entrance. Its mouth is guarded by a delta of several islands, between which the waters escape from Lake Alexandrina by five channels. They all unite and discharge to the sea through one narrow aperture, the navigability of which varies greatly in different years. Thus, Captain Douglas, in 1857, reported that one steamer, the *Corea*, had crossed the bar in winter with full cargoes, drawing 8 feet 4 inches, twenty-six times in three months; and he considered that with care and judgment the navigation of the mouth was neither difficult nor dangerous. But by March 1859 changes had taken place at the mouth which compelled him to withdraw this favourable opinion. Lieutenant Goalen, who resurveyed the Murray mouth in 1876, was also of the opinion that it could be navigated at any time in specially constructed boats drawing not more than 7 feet of water.[1] At that time the

[1] *Parl. Papers S. Australia*, 1876, No. 108.

main discharge of the Goolwa channel was 3,767,000 cubic feet per minute, while the Holmes' Creek or Mundoo channel discharged 285,000 cubic feet, and the discharge from the three creeks which flowed into the Coorong was 980,000 cubic feet per minute.

The frequent shifting of the shoals at the mouth is attributed to the complex eddies caused by water from the main or Goolwa channel meeting the currents from the shorter, more direct branch known as Holmes' Creek, and from Boundary Creek, and the two creeks passing one on each side of Tauwitchere Island, opposite the mouth. It was therefore proposed to reduce the eddies by separating the Goolwa current from the others, and thus let it flow out to sea undisturbed by tributary currents. Holmes' Creek was to be converted into a straight channel, directed at the mouth. But Sir John Coode, who was engaged to report on the question, considered that the bar was due to an external cause, and that the proposed alteration would not remove it, and would probably ruin the important Goolwa channel. He considered that the only mode of dealing with the Murray mouth would be the construction of breakwaters running out to a depth of six fathoms of water, at a cost of not less than £2,000,000.

More satisfactory progress has been made in opening the upper river to steamers by the removal of snags. £368,479 has been spent, up to 1903, in removing snags and overhanging trees, and cutting through the shallow bars. Seven hundred miles had been practically cleared by 1858, under the superintendence of Captain Cadell, at the cost of the Governments of South Australia, Victoria, and New South Wales.

Owing to the excessive sinuosity of the Murray long, light draft steamers and streams of barges, such as those used on the Mississippi, are impracticable; but by the

snagging of the river at the joint expense of the three adjacent States the river is navigable to light draught, stern-wheel steamers towing one or two barges.

The *Lady Augusta* could carry up, with the aid of a barge, 140 tons, and could bring down 600 bales of

Copyright. *The Agent-General for Victoria.*

GRAIN BOAT ON THE MURRAY.

wool. The first steamers on the river drew only 21 inches.

There are now ninety registered steamers on the river, and the same number of barges, the largest of which are of 300 tons burden.

In ordinary seasons the river is navigable up to Albury from July to December, but during the drought of 1902 there was no navigation above Morgan.

The development of the river trade is hampered by the preferential rates given by the railway companies;

thus the charge for carrying sugar from Melbourne to Echuca (156 miles) is, if the sugar be for the Darling, 11s. per ton, which is the same as that from Murray Bridge to Port Adelaide (69 miles); whereas the rate is 50s. per ton if the goods are for consumption at Echuca.

The use of the Murray for navigation conflicts with its still greater possible use for irrigation. The soils of the Murray Plains, thanks to the arid climate, are of exceptional fertility. As Professor Hilgard has pointed out, the soil of arid regions is rich in consequence of the aridity. "Arid countries are always rich countries when irrigated." This is a necessary consequence of the geological origin of their soils. The weathering of primary rocks produces débris rich in materials that are required for plant-growth, especially compounds of the alkalies, potash, and soda, as well as lime, magnesia, and phosphoric acid. These valuable but soluble constituents are washed out of the soil in regions of heavy rainfall and carried by the rivers to the sea. In arid regions, on the other hand, these substances collect in the soil and give it exceptional fertility. Such arid regions can only be watered by irrigation. And the area of land in the Murray basin that could be used, if water were available for irrigation, would make an enormous addition to the wealth-producing capacity of Australia.

According to the Murray Commission (*Report*, p. 22), the following are the irrigable areas in the Murray basin :—

[TABLE

	Acres.	Acres.
New South Wales		
Darling and tributaries, irrigable by gravitation	22,387,200	
Lachlan, irrigable by gravitation	9,539,200	
Murrumbidgee, irrigable by gravitation	6,995,840	
Murray, irrigable by gravitation	4,620,160	
		43,542,400
Victoria		
Murray and tributaries, irrigation by gravitation	4,000,000	
		4,000,000
South Australia		
Murray, pumping to 110 feet level	1,000,000	
,, ,, 160 ,,	1,500,000	
		2,500,000
Total area in the three States		50,042,400

The table shows that South Australia has far less to gain by the use of the Murray for irrigation than New South Wales or Victoria; and it has more to gain from the river trade, as that might lead a great part of the trade of the Darling and the Murray to Adelaide. The interests of South Australia are, therefore, diametrically opposed to those of the two other States which contribute the water to the river. New South Wales and Victoria grudge sending water, which they so badly need, to the Lower Murray, where it is lost by evaporation from the Lakes Alexandrina and Albert. According to Mr. J. W Jones[1] (the Secretary of the Public Works Department of South Australia) Lake Alexandrina has an area of 220 square miles, and a depth of from 7 to 10 feet, and Lake Albert an area of 64 square miles, and a depth of from 3 to 6 feet; according to his observations the evaporation during the years 1881-1901 were:[1]—

[1] Inter-State Royal Commission on the River Murray. *Report of the Commissioners*, p. 211.

Mean annual maximum	71·54 inches.
Mean annual minimum	42·95 ,,
Mean annual mean	57·17 ,,

The mean annual rainfall at the Hope Valley station for the same period was only about 21 or 22 inches.

The rapid evaporation from the surface of the two lakes leads to an annual loss calculated at no less than 42,000,000,000 cubic feet of water. Hence a continuous flow of 80,000 cubic feet per minute is required to replace it; and it has happened, at times of severe drought, that the inflow of the Murray into these lakes has been insufficient to maintain the loss of evaporation, and the Murray has no discharge to the sea. The sea-water then works its way into Lake Alexandrina, the waters becoming so salt that it is useless for stock; and during the severe drought of 1902 sea-fish, such as garfish, ascended the Murray as far as Murray Bridge.

Hitherto the withdrawal of water for irrigation is so insignificant in comparison to the loss by evaporation and percolation, that it has had no effect on the navigability of the river.

After prolonged controversy, a scheme for the utilisation of the Murray has been agreed upon by the three States. The scheme proposes first to regulate the discharge down the river, and prevent the present alternation of periods when the river is useless, or even a source of disaster from its floods, and periods when it is useless owing to being so low. The variations in the discharge of the Murray River are enormous. The Darling usually flows between well-defined clay banks 30 to 40 feet high; but in 1890, owing to heavy tropical rain in Queensland, the river rose above its banks and spread for miles across the country. Steamers between Wentworth and Bourke travelled for hours without

seeing any land, and in one instance discharged cargo 25 miles from the ordinary channel of the river.

In the still greater flood of 1870 a steamer went from the Darling along the course of the Paroo to beyond the Queensland border for 180 miles, the spread of the water being at that time 60 miles wide. At Wilcannia, the discharge of the Darling during 1890 reached the volume of 700,000,000,000 cubic feet. After the heavy drought of 1902-1903, the Darling ceased to flow for eleven months, from February 1902 to January 1903. The variations in the Murray are less extreme but still abnormal. The total discharge of the Murray at Mildura for 1902 was only 57,677,000,000 cubic feet, or only 5 per cent of the highest known discharge. In the flood of 1870 the discharge was 1,141,728,000,000 cubic feet, and during the height of the flood the flow was 6,000,000 cubic feet per minute. Whereas in April 1903 the river fell to a flow of 14,400 cubic feet per minute.

The Murrumbidgee at Hay discharged 400,000,000,000 cubic feet in 1894, and only 18,500,000,000 cubic feet in 1902.

The artificial regulation of the Murray is proposed by a series of weirs. It is proposed, at the cost of £787,500, to build a dam across the Upper Murray at Cumberoona, 55 miles above Albury; the dam is to be 8000 feet long and 70 feet high, and it is expected to impound 25,367,000,000 cubic feet in an artificial lake 23 square miles in area. The discharge from it, added to that from the Mitta and the Kiewa, would yield a continuous flow of 180,000 cubic feet per minute throughout the year. A second weir is proposed, at the cost of £84,000, below Lake Victoria (50 miles from the South Australian border), which will keep that lake filled during the winter,

and thus provide 100,000 cubic feet per minute for four months. It is also proposed to provide a series of locks. It has often been pointed out that the Murray, Darling, and the Murrumbidgee are all specially adapted for locking, owing to their very low fall. According to Mr. J. W. Jones, the fall from Mildura to the mouth of the Murray is only 3 inches per mile; and thus one lock would maintain a navigable depth of water for a great length of the river. The Darling is often naturally locked by floods in the Murray, which bank up the Darling waters. Twenty-six locks are proposed for the Murray between Blanchetown and Echuca, twenty-four on the Darling, and nine on the Murrumbidgee, between the junction of the Murray and Hay. The estimated cost of these locks is £2,500,000.

The legal rights of the three States in regard to the Murray are remarkably uncertain. The watercourse of the Murray was given by an Act of the Imperial Parliament entirely to New South Wales. Section 5 of Imperial Act 18 & 19 Vict. cap. 54, decrees:[1] "Whereas by an Act of the fourteenth year of Her Majesty, chapter fifty-nine, it is amongst other things enacted that the territories therein described should be erected into a separate colony, to be known and designated as the colony of Victoria. And whereas doubts have been ascertained as to the true meaning of the said description of the boundary of the said colony, it is hereby enacted that the whole watercourse of the River Murray, from its source therein described to the eastern boundary of the colony of South Australia, is and shall be within the territory of New South Wales." The legal authorities, however, differ as to the interpretation of this clause. According to the advocates of New

[1] Inter-State Commissioners' *Report on the Murray*, pp. 43-44.

South Wales, the watercourse includes not only all the bed of the river, but also all the water above the bed. According to the advocates of Victoria, the Act merely gave New South Wales the bed of the stream, leaving to Victoria the south bank above the normal level of the river, and the right to share in the water. Legislation upon the navigation of the Murray is admitted to be exclusively in the power of New South Wales.

The rights of the three States to use the Murray waters depend upon the interpretation of the word "reasonable" in the clause in section 100 of the Australian Federal Constitution, which gives the States "reasonable use" of the waters of the Murray. The interpretation of this word will, no doubt, depend upon the relative importance of the water to the conflicting industries, and of the relative importance of the industries themselves. The industry which is the most important will have prior claim on the water.

As a compromise between the conflicting interests of agriculture and navigation, the Inter-State Commission divided the year into a period of seven months, July to January, when navigation is possible, and a period of five months, when navigation is possible only at extravagant cost. The Commission recommended that the waters of the Murray should be apportioned among the three States as follows:—

For the Seven Navigating Months

	Cubic Feet per Minute.	Cubic Feet in Millions per Annum.	Per Cent.
New South Wales	292,000	90,403	37·7
Victoria	146,000	45,201	18·8
South Australia	337,000	104,335	43·5
		239,939	100

FOR THE FIVE NON-NAVIGATING MONTHS

	Cubic Feet per Minute.	Cubic Feet in Millions per Annum.	Per Cent.
New South Wales . . .	240,000	51,840	54·9
Victoria	127;000	27,434	29·1
South Australia . . .	70,000	15,120	16·0
		94,394	100
		334,333	

South Australia, which has the most direct interest in the shipping industry of the Murray, regarded this division as unfair; and it was altered at a conference between the Premiers of New South Wales, Victoria, and South Australia. They agreed that if the volume of the river at Morgan fell below 337,000 cubic feet per minute, the three States should suffer a *pro rata* reduction, so as to bring the volume up to that amount. The Premiers also agreed that Victoria and New South Wales should not take their share of water from the Upper Murray during the non-navigable season, from February to June, when the volume at Mildura falls below 150,000 cubic feet per minute. This arrangement would have allowed South Australia a continuous flow of 150,000 cubic feet per minute instead of 70,000 cubic feet, which the Royal Commission recommended; but it was so severely criticised by the Press in New South Wales and Victoria, that the agreement was modified. South Australia then agreed that when the volume at the South Australian border falls below 150,000 cubic feet per minute, each State shall suffer a *pro rata* reduction, and that then New South Wales should be entitled to $\frac{19}{44}$ of the total volume, South Australia to $\frac{15}{44}$, and Victoria to $\frac{10}{44}$. Without this modification South Australia would have been entitled to the whole of the flow of the Murray during the seven

months of 1902-1903. The upper States would not have been allowed to divert any water for purposes of irrigation: while this sacrifice would have been useless to South Australia, as the volume of water would not have been sufficient to allow of navigation in the lower part of the Murray.

CHAPTER X

THE AUSTRALIAN COMMONWEALTH

THE whole continent of Australia was in the early days of its settlement far too large to be governed efficiently from one centre. Overland communication was then impossible between the eastern and western Settlements; and it was expensive and tedious between the towns of the eastern States. Communication by sea was irregular; communication by steamer between Sydney and Melbourne was begun in 1840 by the *Clonmel*; but she was soon wrecked at Corner Inlet, and her successor the *Sea Horse* was wrecked at the mouth of the Tamar.[1] The interests of the different colonies, moreover, introduced conflicting ideals, which, with the difficulties of communication, rendered it geographically indispensable that Australia should be divided into separate States. They were established in the following order:—

1.	New South Wales.	First colonised	1788
2.	Tasmania	Separated from New South Wales	1825
3.	Western Australia	Founded as the Swan River Settlement	1829
4.	South Australia	Founded	1836
5.	New Zealand	First colonised	1839
6.	Victoria	Separated from New South Wales	1851
7.	Queensland	Separated from New South Wales	1859

[1] W. Westgarth, *Australia Felix*, 1848, p. 206.

Victoria was first settled as the Port Phillip District of New South Wales, and Queensland as the Moreton Bay District. With the improvement of inland communications, the punctuality of over-sea passage by steamers, and the development of Australian wealth and trade, the separation of the States was marked by serious inconvenience. The States, with the exception of New South Wales, all adopted a protectionist policy. Each State had different tariffs, and it was manifestly impossible to keep an adequate customs guard over the long, intercolonial frontiers. There was consequently occasional friction between the free trade state and its neighbours, and continual expense in guarding the frontiers against smuggling. A customs union between the States was therefore desirable. A united scheme of defence became also necessary. Australia is protected by its geographical position from serious attack, and it would be difficult of invasion owing to its magnificent distances. It is, moreover, self-supporting and self-feeding. Its coasts, however, are liable, in case of war, to raids by warships. It is, therefore, advisable that the whole of the defence arrangements of Australia should be on a common plan, and be directed, in case of war, by single control. The increasing political and commercial importance of the Pacific problems were early foreseen in Australia, whose statesmen recognised that Australian interests in Oceania could be best defended by a Minister speaking with the authority of united Australia.

The first active step in favour of federation was a conference of the Premiers, who met in Sydney in 1889, and agreed as to the advisability of the early union of the various colonies. The proposal was approved by all the States of Australia, by Tasmania, and New Zealand. In accordance with this decision a National Australasian

Convention met in 1891. It consisted of seven representatives from each of the Australian colonies, and three from New Zealand. It prepared a federal Bill for the constitution of the Commonwealth. The details were discussed for several years, and were submitted to the electors of New South Wales, Victoria, Tasmania, and South Australia in June 1898. The elections resulted in a majority of 100,520 who voted in favour of the Bill, against 22,099 on the other side. In New South Wales, however, the necessary majority was not obtained; and Western Australia, Queensland, and New Zealand were not ready to join the union.

A further conference was held in Melbourne in February 1899, and was attended by representatives from all the Australian States, but not from New Zealand. This Conference modified the original Bill. The amended scheme was submitted to the legislatures of the various States, which, with the exception of Western Australia, passed enabling Bills to allow the colonies to join the union. The Bills were submitted to a referendum in each of the separate States. The total votes were 422,788 in favour of Federal Union, and 161,077 against it. Western Australia subsequently agreed to join the union, on various concessions due to her scattered population and isolated position. Thus Western Australia was allowed to retain its own customs regulations for five years.

Australia having thus agreed to a Draft Constitution, it was submitted to the Imperial Government in London. Delegates were sent to England to advise the Imperial Government and watch the progress of the Bill through the Imperial Parliament. A few minor amendments were made, and a royal proclamation in 1900 united the

six federating colonies as the Federal Commonwealth of Australia.[1] New Zealand sent a commission to Australia in 1900, but decided not to join the Federation. The Earl of Hopetoun (now Marquis of Linlithgow) was appointed first Governor-General of Australia. The first Commonwealth Parliament was opened in Melbourne on the 9th of May, 1901, by the Duke of York, now Prince of Wales.

According to the Constitution, the executive power of the Commonwealth is vested in the Governor-General, who is appointed by the Sovereign. He is aided by an Executive Council, or Ministry, which is nominally appointed by the Governor-General, but is dependent on the majority in the Houses of Parliament.

The Commonwealth Parliament consists of two chambers—the Senate and the House of Representatives—both of which are elected on a broad franchise, which is practically universal manhood and womanhood suffrage. The Senate, or Upper House, is elected for six years, but half its members have to retire every three years, and they are eligible for re-election. Each State has six senators, the number being the same for each, on the principle that the main duty of the Senate is to protect the interests of the Federating States. The representation of the House of Representatives is determined in proportion to the population. The number of the members has to be as nearly as possible 72, that is, twice as many as in the Senate. No state is at any

[1] Harrison Moore, *The Constitution of the Commonwealth of Australia*, 1902, pp. xx and 396. Sir John Quick and A. Garran, *The Australian Commonwealth*, Melbourne, 1901. Also *Commonwealth of Australia Constitution Bill* (Reprint of Debates, etc.), London, 1900, pp. v and 200. Australia, "Papers relating to the Federation of the Australian Colonies," *Parl. Pap. Gt. Britain*, 1900, pp. iv and 32.

time to have less than five representatives, and the present numbers are as follows :—

New South Wales	26
Victoria	23
Queensland	9
South Australia	7
Western Australia	5
Tasmania	5

The members of both Houses are allowed £400 per annum each for their expenses.

The powers of the Federal Parliament are strictly defined. Most of the functions of government are still kept by the constituent States. The main powers of the Federal Parliament is the determination of the fiscal policy of the Commonwealth; it controls all taxes on trade and customs. Customs administration is, therefore, entirely in its hands; but it is not allowed to discriminate between the separate States, and it is claimed that the Federal Parliament has the power to prevent the States artificially diverting trade by differential railway rates. The second important function of the Federal Government is the military and naval defence of the Commonwealth. It also administers the postal, telegraph, and telephone systems. It further deals with all the external affairs of the Commonwealth. It may control the lighthouses and immigration, and it has already passed regulations for the exclusion of undesirable immigrants. It has the right to take over the astronomical and meteorological observatories, but not to take over geological and ordnance surveys. It may control banking, insurance, weights and measures, insolvency, patents, and copyrights; the laws on marriage and divorce; old age pensions; the control of railways for defence purposes; the acquisition of State railways with the consent of the

States; and laws for conciliation and arbitration between workmen and employers. All powers not specifically entrusted to the Federal Parliament remain under the control of the States. The States accordingly retain their control of education, land development, mining, local taxation, railways and roads, the control of rivers and fisheries within the States' jurisdiction, and the administration of the State debts.

The third constituent of the Federal Government is a Federal Supreme Court, called the High Court of Australia, which at present consists of Sir Samuel Griffith, Chief Justice, and Sir E. Barton and the Honourable R. E. O'Connor as Justices. This Court decides on all matters which belong to the Federal Government, the Supreme Courts of the States still being supreme on other questions. The decision of the High Court is final, except when an appeal be admitted to the Privy Council; but no appeal is allowed to the Privy Council on questions as to the limits of the powers of the Commonwealth and of the States, unless the High Court certifies that the question is one which ought to be decided by the Privy Council. The King has the right to grant special leave to appeal from the High Court to the Privy Council, but the royal prerogative is limited by the preceding provision. The Judiciary Act of 1903 added to the powers of the High Court jurisdiction upon all matters regarding the Constitution or its interpretation. The same Act gives the State Courts power to decide matters included in Federal jurisdiction, but their decisions on all such matters are subject to appeal to the Federal High Court.

The Federal Act pronounces the Commonwealth as indissoluble: but this is admitted to be only an expression of hope, and the Commonwealth could be

dissolved if desired by the necessary majority in the States.

The Constitution can only be altered if the proposed change is passed by an absolute majority in both the Senate and the House of Representatives, and secures a majority of the votes when submitted to a referendum. Any change in the Constitution thus supported will be submitted for assent to the Imperial Government. If the proposed amendment has been passed twice in one House by an absolute majority, and the other House rejects it, or passes it with an alteration to which the other House will not agree, then the Governor-General may submit it to a referendum. No reduction of the proportionate representation of a State or the minimum of its representatives in the House of Representatives, or limitation of the rights of a State, can be made unless approved by the majority of the electors in that State.

The Federal capital is to be in New South Wales, at a distance of not less than 100 miles from Sydney. Its territory is to consist of not less than 100 square miles, and any Crown Lands included in the area that is selected for the Federal capital are to be given by New South Wales without payment. Until the Federal capital is selected and ready for occupation, Melbourne is the acting capital. A commission to report upon the most suitable sites that had been proposed for the Federal capital was appointed in 1901.[1] The commissioners recommended Tumut, on the grounds of its fine situation and climate, its excellent water-supply, and its easy access from the railway lines from Melbourne to Sydney.

[1] "Australia-Capital, New South Wales. Report of the Commission on Sites for the seat of Government of the Commonwealth," *Parl. Pap.*, *N. S. Wales*, 1900, pp. vi and 96. Map. Sydney.

It is also at a good distance from the coast, and therefore safe from attack. The House of Representatives in October 1903 recommended Tumut by a majority of 36 against 25. The Senate, however, substituted Bombala for Tumut, the ruling motive for this change probably being that the proximity of Bombala to the coast would enable it to have an independent access to the sea through Twofold Bay. The matter was again brought up for discussion in 1904, when both Houses selected Dalgety, a town on the Snowy River in the neighbourhood of Bombala. A tract of ground was selected around Dalgety, extending from the Victorian frontier to Twofold Bay. New South Wales has not yet agreed to cede this territory to the Federal Government, a powerful party in New South Wales desiring that the Federal capital should be in Orange, or some position on the Highlands to the west of Sydney.

Until the Government of New South Wales and the Federal Government agree on this matter, Melbourne remains the acting capital.

The financial arrangements between the Commonwealth and the States are conducted under an agreement known as the Braddon Clause, which is valid till 1911, and the renewal of which, for thirty years, has been recommended, in February 1904, by a conference between the Federal Treasurer and the State Premiers. As most of the revenue is derived from customs and excise, it has to be collected by the Federal Government, which, after various deductions, returns to each State two-thirds of the balance of the revenue collected in it. The States raise the balance of their revenue from direct taxation, railway receipts, the sale and rent of lands, and mining leases.

The revenue receipts for the year ending June 30, 1904, were as follows:—

	Revenue Collected.	Federal Expenditure charged to the State.	Balance Returned to the State.
New South Wales .	£4,176,390	£1,485,126	£2,691,264
Victoria . . .	3,098,811	1,098,078	2,000,733
Queensland . .	1,458,745	656,114	802,631
South Australia .	959,287	404,559	554,728
Western Australia .	1,490,463	424,474	1,065,989
Tasmania . .	447,360	184,211	263,149
Total . .	£11,631,056	£4,252,562	£7,378,494

CHAPTER XI

NEW SOUTH WALES

New South Wales, the parent State of Australia, was first discovered by Captain Cook in 1770, and colonised in 1788. It lies in the south-eastern corner of Australia, and its coast, 700 miles in length, borders the Tasman Sea.

New South Wales formerly embraced the whole eastern half of Australia; but Victoria was separated from it in 1851, and now forms its southern boundary. Queensland was separated in 1859, and bounds New South Wales on the north and north-west. The rest of the western frontier separates New South Wales from South Australia.

The average width of the State is about 600 miles. Its area is 310,700 square miles, or about 199,000,000 acres, which is approximately the size of Great Britain and France together. With the exception of Victoria, it is the smallest of the States on the mainland of Australia.

The first settlements were on the coast at Botany Bay and in Port Jackson; and progress inland was stopped by the steep front and intricate, precipitous gorges of the Blue Mountains. It was not until 1813 that a practicable route across them was discovered by Blaxland, Wentworth, and Lawson. The Western

Plains were then soon reached, and subsequently explored by Oxley, Sturt, and Mitchell. The Highlands to the south as far as the Victorian border were traversed by Hume and Mitchell, and the northern Highlands by Cunningham.

1. Physical Geography of New South Wales

The geographical classification of New South Wales can best be understood by reference to its geological structure, which may be summarised as follows: the south-eastern corner is composed of Archean and Lower Palæozoic rocks, which are the northward continuation of those in Victoria. These rocks mostly strike from north to south. They build up the whole of the southern Highlands of New South Wales. They are separated from the coast by narrow strips of low country and sand dunes; further northward, these old rocks are separated from the sea, in the Illawarra Mountains, by a strip of the coal-bearing rocks. The old rocks of the south-eastern part of New South Wales send out many projections to the west and north-west; they gradually decrease in height as they are followed northward, until in the basins of the Hunter and Upper Erskine or Talbragar (a tributary of the Macquarie), they disappear below the Upper Palæozoic rocks, which contain the great coalfields of New South Wales. To the north of this area the older rocks reappear and are continued, as the New England Tableland, to the Queensland frontier. The north-eastern corner of New South Wales between the New England Tableland and the Tasman Sea, comprising the basins of the Richmond, Clarence, Macleay, and Manning Rivers, is composed of Carboniferous, Devonian, and Mesozoic rocks, with some granites

and basalts, which extend as far south as the Liverpool Mountains and the Manning River. To the west of the Palæozoic rocks, which range from New England to the Victorian border, New South Wales is mainly occupied by the Cretaceous and Cainozoic rocks of the Western Plains. They are interrupted by north-western extensions of the Lower Palæozoic rocks, which occur on the western bank of the Bogan River, and form the whole country around Cobar. Beyond the Western Plains an area of Archean rocks occurs in the far west, forming the Barrier or Stanley Range. But with these exceptions the whole of New South Wales, to the west of the old Highlands, consists of the Great Plains of Upper Mesozoic and Cainozoic deposits.

New South Wales can be divided into four main geographical divisions: the Coastal District, the Highlands of New South Wales, the Western Plains, and the area of old rocks on the Western border, forming the Barrier and Grey Ranges.

2. The Coastal District

The Coastal District is as a rule about 35 to 45 miles in width. It consists of undulating country which lies between the Tasman Sea and the eastern foot of the New South Wales Highlands. In the Hunter Valley the width is 150 miles, while at Illawarra it is not present at all, as the Highlands reach the shore. To the south of Lake Illawarra the Highlands recede from the sea for a while; and further south, though the old rocks come close to the coast from Moruya to Cape Howe, the Coastal District extends westward up the Moruya, Tuross, and Towamba Rivers, to the foot of the scarp known as the Gourock and Wanderer Ranges.

Photo. *A. E. Kitson.*

MORAINE-DAMMED TARN ON MOUNT KOSCIUSKO, N.S.W.

3. The Highlands of New South Wales

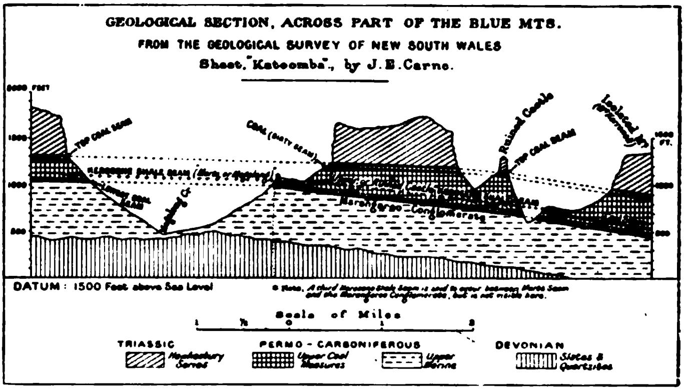
The Highlands or great tablelands of New South Wales extend from north to south across the whole length of the State. They vary in width from 30 to 100 miles, and the average height is about 2500 feet. Their highest points are, in the south, Mount Kosciusko (7256 feet), and, in the north, Ben Lomond (5000 feet). The belt of Highlands is divided into three main tablelands; the northernmost is known as the New England Tableland, and runs from the Queensland frontier southward to the depression between the head-waters of the Peel River and the Manning River. It is about 150 miles long from north to south, and about 45 miles broad, with an area of about 4,250,000 acres. Its height may be judged from the fact that the Northern Railway runs for 130 miles across it without falling below the level of 3000 feet, and at Ben Lomond Station it is 4473 feet high. Ben Lomond itself is 5000 feet high, and the average elevation of the tableland is about 3500 feet. An outlier to the south of this tableland forms the Liverpool Range, to the north of the Hunter River; this range is crossed by the Northern Railway at Ardglen, at the height of 2073 feet. The second main division of the Highlands forms the tableland of the Blue Mountains, west of Sydney, crossing which the Western Railway is generally over 3400 feet above sea-level. The Blue Mountains are separated by the Cox River from the great Southern or Monaro Tableland, the height of which is a little over 2000 feet at Goulburn, and 2400 feet on the Cullerin Range, between Goulburn and Yass; it rises southward across the Monaro Plains to Mount Kosciusko (7256 feet), the highest point in Australia. These Highlands bear upon their

surface many mountain ranges; they have been left by denudation, which has planed down the old mountains that once covered the site of these ancient tablelands. The Highlands are traversed by the watershed which separates the drainage into the Pacific from that into the Darling and the Murray. The rivers have cut deep valleys through the old tablelands. The ridges thus left trend either eastward to the coast or westward to the Western Plains; they separate the basins of the different tributaries of the Murray, forming the divides between the various coastal rivers. These spurs from the Highlands form the most numerous and best known of the mountain ranges of New South Wales. The watershed between the Murray and the coastal rivers is, owing to its importance, described as the Great Divide, and treated as a single mountain system. The Highlands themselves are sometimes described as the Australian Cordillera, and sometimes as the Great Dividing Range, though the latter term is generally restricted to the actual divide. Both terms are somewhat misleading to European students. The course of the Main Divide is very sinuous, and depends on a complex of geographical accidents. It is not a mountain range in the sense in which that term is usually adopted; and the Highlands are essentially distinct in structure from that of the Cordillera of South America.

The mountains of New South Wales result, in the main, from the dissection of plateaus by river action. "The uplands of New England, the Blue Mountains, and the Darling Downs are," says Andrews,[1] "in a very youthful stage of dissection, and their marvellous gorges and cliffs—expressions of this youth—by reason of their

[1] E. C. Andrews, "Tertiary History of New England," *Rec. Geol. Surv. N. S. Wales*, vol. vii. (1903), p. 141.

diverse forms, compel the wonder and excite the curiosity of the passer-by. In the north one observes the terraced appearance of the plateau, the effect of the desolating winter wind on the same, the alternating expanses of granite plain studded with quaint tor, of curiously contorted slate or fertile lavas, mighty Phlegræan fields of old time now silent and cold, which compose its surface.



A SECTION ACROSS THE BLUE MOUNTAINS, WEST OF SYDNEY.

Showing the plateau and stacks and the geological structure of the country.
(By J. E. Carne.)

These are all trenched, on their eastern borders, by numerous and wonderful V-shaped canyons, inaccessible at their heads, and several thousand feet deep but a few miles down the stream courses from the first cascading of the torrents.

"Typical of the scenery obtaining in the north-eastern portion of the uplands are the sunlit gorges of the South Clarence. Here the head-waters of the river take flights over lava sheets, whose symmetrical columns form giant ramps to the natural trenches, at times clustering together

as groups of pilasters or advancing into the valley as buttresses half-buried in their own debris.

"The Macleay mountain tract forms a plexus of sunless gulches that wind through wild, precipitous, granite blocks, several thousands of feet in height, and basaltic ranges clad with marvellous forest and wreathing jungle, to form an anastomosing series of defiles simulating leaf venation in plan.

"Grandest of all are the peaks of the Macpherson Range, where Mounts Lindsay, Warning, Barney, and associated masses magnificently overtop the southern extension of the Darling Downs. Wondrously isolated, their fanciful outlines admit of easy study. Lindsay, although dismantled in part by time, still presents an inaccessible summit to the climber, and dominates the landscape for over seventy miles in several directions.

"Thence to the coast the mountain piles dwindle in height, and become less and less separable from the gentle undulations of certain portions of the coastal areas.

"West of Sydney other wondrous forms are to be found. Here the bleak sandstone plateau of the Blue Mountains yields, even under generous rains, but a reluctant vegetation. Harsh and monotonous scenes are characteristic of this upland surface. Nevertheless, it treasures in its depths canyons whose profiles present marked differences from those of the terrifying clefts of the Macleay. Waterfalls of great height occupy niches in the mighty tiers of masonry which sweep round the valleys in parapet form and stretch away 'illimitable to the horizon.' Fertile shales underlie the massive sandstone ramparts, and support luxuriant vegetable growths, presenting marked contrasts to the forbidding aspect of the sterile sandstone."

The Highlands are divided into three main tablelands,

and each has now an undulating surface; for they have been dissected by rivers that have cut valleys through them from 2000 to 3000 feet deep. The valleys have such steep walls, with vertical cliffs 600 feet in height, that they are sometimes true canyons. These deep valleys have so broken up the plateau, that the old plain surfaces can only be recognised in broad general views. The Northern or New England Tableland is traversed by the railway from Sydney to Brisbane, which is forced to follow along the highest part of the tableland in order to avoid the deep ravines and wide valleys on its edges. It keeps at a distance of about twenty miles from the eastern edge, and passes within about 500 feet of the top of Ben Lomond (5000 feet), the highest peak in New England.

The rivers that rise on the remnants of the old tableland flow in broad shallow valleys to their edge, and then leap over the cliffs in the picturesque waterfalls which are among the many attractions in the famous scenery of the Blue Mountains.

Parts of the old plateau surface remain between the valleys and form rolling down country, which is used for sheep stations, or, especially in New England, for farming. Wheat and dairy produce are the main products.

The chief plains left on the Highlands are the Barney Downs, east of Tenterfield; the Beardy Plains, north of Ben Lomond; the plains round Bathurst, Goulburn, and Yass; and the Monaro Plains on the south-eastern corner of New South Wales, near the Victorian frontier.

The classification of the mountains which form the New South Wales Highlands depends upon the geological structure of the country and on its denudation by the rivers. Ridges, each of which separates two river

valleys, extend eastward to the coast from the main mass of the Highlands. The first of these eastward projections from the Highlands is known as the Macpherson Range; it divides the basins of the Richmond and Clarence Rivers of New South Wales from the Logan and Nerang Rivers in Queensland. To the south of the Clarence basin is the Macleay Range, which separates the Aberfoyle and Guy Fawkes Rivers, both tributaries to the Clarence, from the Macleay River. Then follows the Hastings Range, or the North Coast Range, which forms the watershed between the Macleay and the Hastings Rivers; but, by an accident of denudation, its outlier, Mount Sea View (3100 feet), has been left apart from the range, on the southern side of the Hastings River. The next leading spur, which runs eastward from the Highlands, is known as the Mount Royal Range, which forms the highest part of the country between the Manning River on the north and the Hunter River on the south. The Hunter Range, which separates the basins of the Hunter River and the Hawkesbury, is the next prominent east and west spur. To the south of the basin of the Hawkesbury is the Illawarra Range, which reaches the coast close to Lake Illawarra. It is the last of the east and west ranges; as farther south, owing to the rocks having a well-defined strike from north to south, the rivers flow in strike valleys in the same direction. They escape to the coast through short transverse valleys. Hence in the southern part of New South Wales the most conspicuous ranges east of the main divide run parallel to the coast; they include the Goulburn Ranges, which separate the Shoalhaven on the east from the basin of Lake George and the head-waters of the Murrumbidgee on the west. Then follows the Monaro Tableland, the great southern peneplane, which

is cut up into a series of meridional ridges; they are formed by the rivers such as the Tumut, Coodradigbee, the upper Murrumbidgee, the Queanbeyan, and the upper Shoalhaven, which all flow from south to north. The southern peneplane faces the east with the Gourock

Photo. *A. E. Kitson.*

BLACK CREEK HUT, ON THE KOSCIUSKO TRACK, NEAR KHANCOBAN, N.S.W.

Range. This range is continued southward by the Wanderer Range, a projection from the highlands of Croajingolong, the easternmost province of Victoria. On the western side of the southern Highlands is the part of the Australian Alps belonging to New South Wales: it is known as the Muniong Range. It is connected to the Bowen Range of Victoria, and passes northward into the Tumut Range—the ridge left

by the denudation of the Tumut and Coodradigbee Valleys. To the east of the Wanderer and Gourock Ranges the short coastal rivers to the Pacific are separated by undulating country of granitic and Lower Palæozoic rocks, which here reach the shore. The chief summits of this southern coastal district are Mount Imlay, Mount Brierly, and Mount Dromedary.

The chief part of the Highlands in northern New South Wales is the New England Plateau, which separates the tributaries of the Clarence River on the east from the head-waters of the Macintyre River on the west. This plateau is traversed by the Great Northern Railway of New South Wales, from Sydney to Brisbane. It is a valuable agricultural country, and beneath its sheets of basaltic lavas are alluvial deposits rich in tin. To the south of the New England Plateau the Main Divide turns abruptly to the west and runs along the Liverpool Range, which is the southern end of the Liverpool Plains. This change in direction is due to the existence of a sheet of basalt which has resisted denudation. To the south of the basalt are softer Carboniferous rocks, along which the Hunter River has been able to cut its valley backward much farther to the west than any other coastal river. To the south of the Hunter River the Divide turns eastward again, and then goes southward across the district popularly known as the Blue Mountains.[1] They occur between the head-streams of the Colo, Grose, Cox, and Browning Rivers, which are all tributaries of the Hawkesbury; and the sources of the Turon and Campbell, which flow through

[1] The name of the Blue Mountains is not usually accepted officially, and the name is used for mountains which look blue in the distance in nearly all parts of South-eastern Australia; but the Blue Mountains *par excellence* are those west of Sydney, and the name is accepted by Professor David and other New South Wales geographers.

the Macquarie River into the Darling; and, to the south-west, the Abercromby, a tributary of the Lachlan.

The dissected plateau country to the west of the Blue Mountains is known as the Macquarie Ranges; its highest summit is Mount Canoblas (4610 feet), a group of peaks of trachyte and andesite. This district includes Sofala, and the Turon River, famous as the seat of the first gold-diggings in New South Wales, and Orange, the site for the Federal Capital favoured in New South Wales. The most westerly part of these Macquarie Ranges runs past Molong, and is continued as the Curumbenya Range, which is composed of granitic and Silurian rocks, and dips under the Western Plains north of Parkes.

South of the Blue Mountains the Divide crosses the plateau around Lake George and Goulburn. The country to the north-west is known as the Mundoonan Range (3000 feet), which separates the upper basins of the Lachlan and Murrumbidgee. The Main Divide then goes southward along the Gourock Range. The Divide then doubles northward across the Monaro Plains, and passes Mount Murray north of Kiandra, and thus around the head of the Snowy River. Then it doubles again along the Muniong Range, and reaches the highest part of the southern plateau on Mount Kosciusko, the name of which was given to it by its discoverer Strzelecki, owing to the resemblance of the hump which forms the summit to the tumulus erected over the grave of Kosciusko. This is the highest point in the Australian continent. Its height is accepted in 1902, by the Inter-State Royal Commission on the Murray, as 7256 feet. The accidental course of the Divide in this district is shown by the fact that at Kiandra, the present drainage is south into the Snowy River, whereas

during the deposition of the gold-bearing gravels, for which Kiandra is famous, the rivers flowed northward into the Murrumbidgee.

The western ranges, which project from the Highlands, begin on the north, with the different subdivisions of the district known as the Liverpool Plains. They occur to the west of the New England district, in the upper basin of the Darling River. The best marked of these ranges is that which forms the secondary divide, between the Gwydir and the Namoi Rivers. It is known as the Nandewar Range. Its highest peak is Mount Lindsay, and it includes some extinct volcanoes, as at Bingara. North-westward from the Liverpool Range is the Warrumbungle Range, which includes the mountains around Coonabarabran, consisting of basalts and trachytes resting on a foundation of Permo-Carboniferous rocks; the highest summit, Mount Exmouth, is about 3000 feet high.

To the south-west of the Bogan River is the great north-westward projection of Lower Palæozoic and Devonian rocks which forms the mining-field of Cobar, and reaches, with slight interruptions, beyond the Darling River. To the south of the Lachlan, and north of the Murrumbidgee, is another projection from the Highlands, of which the base is a line from Cootamundra to near Wagga-Wagga. Its most western continuation is the Cocoparra or Peel Range, a ridge of Devonian rocks trending from west-north-west to east-south-east.

The Tumut Range is the northern end of the Muniong or Snowy Range, and lies between two tributaries of the Murrumbidgee, the Tumut River on the east, and the Goodradigbee River on the west.

The geographical structure of the mountains of New

South Wales shows that they now contain nothing comparable to the Cordillera of South America; but there was once. In Middle Palæozoic times a great mountain chain, formed of folded rocks with granite nuclei and vast intrusive sheets of acid and basic igneous rocks, extended north and south throughout New South Wales. But this old mountain chain has long since been destroyed. The mountains have been completely planed down by river action, and their site thus converted to that type of plain known as a peneplane. This plain had a long gradual slope downward to sea-level at the coast. It was then uplifted and became a plateau. The river action which had formed the plain, renewed its action and attacked the plateau and cut deep valleys through it; the valleys grew wider until their floors formed a second peneplane with a gradual slope eastward to sea-level. The surface of this plain was broken here and there by remnants of the old plateau, which stood as flat-topped mountains above the general level. Then the second plain was in its turn raised to a plateau; once again the rivers renewed their attack on the land and cut deep valleys through it, and widened them to form a third peneplane. Above this third plain rose the terraces of the second plain, and the highest summits belonging to the first plain. This process has been repeated several times, either by uplift of the interior or the sinking of the coast. The last of these geographical cycles began, geologically speaking, at a comparatively recent date—the Pliocene. Then the country, some distance from the present coast, was left standing, 3300 feet above the coastal districts, owing to their subsidence. These earth-movements gave New South Wales the main outlines of its present geography.

The country still shows abundant evidence of the

former plains and their old river valleys, which date since the last great earth-movements. The surface of the tablelands is traversed by broad, flat-floored valleys, on the floors of which there are wide sheets of rich alluvium, and the hills beside them have gently rounded slopes. Then, at both edges of the tablelands, the rivers suddenly plunge in waterfalls over high precipices, and continue through gorges, sometimes 3300 feet in depth, which have the characters of very young valleys. The most famous scenery of New South Wales is that of the eastern border of the plateau. From the famous "Look-out" points of this region the views to the west show the undulating surface of the tableland; but to the east we look into deep, young V-shaped valleys, and over the low-lying hills of the coastal district to the sea. Darwin has given a well-known description of this scenery; and he was so impressed by the eastern face of the plateau, that he was forced to the belief that it was due not to denudation, but to the ending of a vast bank of sediment deposited by the sea. The correct explanation of this country we owe to Professor David, who has shown that the Blue Mountains west of Sydney owe their characters to a great monoclinal fold. The same rocks occur on the summit of the Blue Mountains, 3300 feet above the sea-level, as on the shores around Sydney. On the summit of the Blue Mountains they are nearly horizontal; on passing eastward they slope downward to the sea-level, and then continue again more horizontally, until they pass below sea-level at Sydney.

The rivers at first flowed eastward to the sea, and as their course was consequent on the slope of the rocks, they belong to the category of consequent rivers. Subsequently their courses and the growth of their tributary valleys were moulded by the varying resistance of the

rocks; the valleys growing most readily along the bands of weaker rocks. Thus in some parts of New South Wales the courses of the original "consequent" rivers have been destroyed, and the rivers flow through valleys worn out subsequent to the earth-movements, which determined the first slope of the country; the course of these "subsequent" rivers, to use Professor David's term, is due to the trend of the rocks.

The geological structure and geographical character of the Northern or New England Plateau has been well described by Mr. E. C. Andrews, of the Geological Survey of New South Wales, whose paper on the "Tertiary History of New England" gives a full account of the development of the topography of this part of the country, and descriptions of the scenery showing keen geographical insight. According to Andrews, the northern tableland of New South Wales may be taken at from 150 to 200 miles in length. Its eastern border is excessively complex and irregular, as its margin winds round the heads of the streams, while the undercutting of waterfalls has cut deep V-shaped valleys far backward into the plateau. The view-points upon the eastern edge of the plateau, which have such names as Guy Fawkes' Look-out, Wilson's Downfall, etc., command views into the deep ravines, some of which are 3300 feet deep. Between the ravines peninsulas from the plateau run out eastward; and beyond the peninsulas are isolated and inaccessible blocks, which have been cut off from the plateau by the meeting of subsequent streams working northward and southward from the main east and west valleys.

"For years," says Andrews,[1] "the upland remained

[1] E. C. Andrews, "Tertiary History of New England," *Rec. Geol. Surv. New South Wales*, vol. vii. p. 158.

inaccessible from the coast, owing to the long lines of granite and slate precipices which formed the heads of the canyons receiving the drainage of the upper areas. Yet in the central portions of the upper levels a stranger to its characteristic features might easily be mistaken as to the nature of the eastern fall. Riding along the 3300 feet level eastwards of the Great Northern Railway, the individuality of the tableland appears to be unbroken. Its general flat rises here and there into mountains of moderate relief. No signs of plateau dissection are visible in the distance; yet, but a few miles ahead, profound canyons may have almost completely cut up the apparently continuous plain into unapproachable masses. Thus, along the upper Macleay, in the neighbourhood of Tia, Apsley, Wooloomumbi, or Salisbury Rivers, the mountains rising above the Sandon plateau may at a distance of several miles appear easily approachable, while in reality a detour of thirty or forty miles may have to be made to arrive at their bases. From the summits of such peaks as the Blue Mountain and the Round Mountain, where the observer is well above the lower tableland, the true nature of the country may, however, be taken in at a glance.

"Characteristically broad, shallow, and sluggish streams, having every appearance of extreme old age, except for the small incisions developed by them in the plain, traverse the plateau for distances varying from 10 to 35 miles, then precipitate themselves over great ledges from 300 to a 1000 feet in depth. Thence, as torrent tracks, their courses are continued through V-shaped gorges several thousands of feet deep."

The plateau contains traces of several distinct levels, each representing a cycle,—the formation of a peneplane and its dissection, in consequence of the uplift. The

highest of these plains Andrews calls the Bolivia Plain; it occurs at two levels, 5000 feet and 4200 feet. Its surface possibly dates from Cretaceous times; but denudation in later times had reduced it to a few isolated plateaus, standing as residual blocks above the surface of the lower plains. The Guyra Plain, at a height of 4300 feet, is composed of sheets of high level basalts.

The Mole Peneplane, at a height of about 4000 feet, occurs around the Mole River, one of the tributaries of the Dumaresq, and also across the head-streams of the Clarence River, on the eastern face of the tableland. Its surface is interrupted by residual blocks of the Bolivia Plains, which form the highest part of the New England Plateau. The Stannifer Plains, at a height of 3200 feet in northern New England, include the tin-bearing country round Emmaville, Vegetable Creek, and Glen Innes.

The Sandon peneplane, at the height of 3300 feet, occupies most of the southern part of the New England Plains around Hillgrove and Walcha.

The drainage from these high plains flows through shallow old valleys toward the Macleay River on the east, and the Namoi River on the west. As soon as the rivers reach the margins of the plateau, they plunge over high falls into the young narrow valleys, which they have cut, in sinuous courses, far backward into the plateau.

The western slopes are less abrupt than the eastern, but they are nevertheless remarkably bold and precipitous. The main rivers rush westward as torrents through rough, narrow gorges, with barren, precipitous sides, cut across a succession of ridges trending north and south. These ridges have been left by the resistance of the harder rocks, and between them are broad valleys, on the floor of which are flood plains of high agricultural value.

The New England Plateau is separated from the southern tableland by the low gap which separates the Hunter River on the east from the tributaries of the Peel River on the west.

From many of the view-points, such as Guy Fawkes' Look-out, may be seen the abrupt eastward face of the plateau, with its rampart 1500 feet in height, of which the base often consists of Palæozoic slates, capped by a sheet of basalt, forming, as Andrews describes it, a "columnar façade."

The Macleay works its way to the coast through a deep valley, in which the river is only 500 feet above sea-level, while the surface of the plateau on either side of it is more than 4000 feet high.

Looking at the country from the bottoms of the valleys, we appear to be looking at lofty, inaccessible mountains; but standing upon their summits, and looking down into the valleys, we see that the country consists of a tableland in which the waterways are merely trenches cut by the streams themselves.

4. The Western Plains

To the west of the New South Wales Highlands occur the great Western Plains, which consist in the north of the Rolling Downs Formation, and farther south, in the basins of the Darling, the Lachlan, the Murrumbidgee, and the Murray, of river silts deposited during floods. The Plains have a slight slope to the west, but the country, as a whole, consists of a vast level expanse, across which roads and railways run for great distances absolutely straight, with but insignificant variations in altitude. These districts include some of the largest true plains in the world. There is only a

slight rise between the different rivers, except where an occasional outlier of older rock remains as the blunt stump of a former hill. The soil throughout is fertile; but owing to the very low rainfall the ground is often arid; and after a dry summer the ground is loose and sandy, except where the evaporation of moisture containing some materials in solution has cemented the soil into sheets of bare, hard, "scorched ground." After heavy rains or floods the country is covered with a rich growth of deep-rooted grasses and other vegetation; but on the return of dry weather the plants gradually wither. During times of prolonged drought the vegetation is reduced to tufts of wiry grasses and succulent plants, such as salt-bush, which can resist drought; to occasional clumps of acacia and hakea, or a few she-oaks, on patches of sand; or a line of gidya trees along some empty watercourse. In most of the country the river-courses can be discerned from a distance by the dark line of timber along them.

The rivers, owing to their low banks and slight slope, cannot discharge the heavy floods from the eastern Highlands; so the water spreads across the country in vast floods, converting it into the appearance of an inland sea. This was the condition of the Western Plains when Oxley first saw them; and during the floods of the Darling steamers have discharged their cargo 25 miles back from the main channel.

The most fertile part of the great plains occurs between the Murray and the Murrumbidgee, in the district known as the Riverina, where, in addition to the great sheep stations, wheat is raised in favourable seasons. The Riverina shows the Australian plains at their best. Their spirit is well expressed by Donald Macdonald.

"There is no part of Australia claiming an individuality more complete than Riverina; and under this title may

be included the great plains stretching to north and south from the Murray River. One may wander in many parts of the continent and yet fail to discover anything that, with a greater dearth of material to produce effect, leaves such a lasting picture upon the memory. Some Australian bush scenes, quite idyllic in their wild beauty, will be forgotten when that long day's ride in the Riverina country is still fresh in the memory. And who that has ridden across the Old Man Plain, and wondered when the placid sea of grass would curl into a billow, or the sail of an inland ship—the hawker's white-ridged waggon—break against the blue sky-line, needs any description of it? This waste land without any limits, summer-bleached and desolate, the monotonous chaos of these endless plains, leave impressions that can never be effaced. What Nature gives, she gives in plenty here. The clumps of box-gums clinging together for sympathy; the desert acacias, the weeping myalls standing singly out on the plain; these are cast lavishly over hundreds of miles. The free, open life in this lone land has a charm for many men, and they stick to it as long as they can manage to climb into a saddle."

The Riverina plains are liable to drought, and the vegetation withers, and the flocks are starved. But, as Macdonald says: [1]—

"Nowhere in Australia will a shower of rain effect a transformation more rapid and complete than in Riverina. One week there is a barren waste, stretching league upon league, the next a thick carpet of succulent herbage. Where not even a withered wisp of kangaroo grass appeared a few days since there are now beautiful plots of rare summer grass. If Riverina bore such a crop everywhere, the pastoralists would be rich, and salt-

[1] Macdonald, *Gum Boughs and Wattle Bloom*, pp. 8-9.

bush would be a despised plant by comparison. Along the banks of the watercourses, that not long since were merely dry depressions in the land, wild melons are springing and spreading so rapidly as to give the place the appearance of a garden."

North of the Riverina most of the western plains are underlaid by beds saturated with water under such high pressure that when these deposits are reached by a bore the water rises to the surface as a flowing well. Thanks to these supplies of water, the country has been improved in value; for stock routes to the better watered areas can be kept open by these deep wells during periods of the severest drought.

5. The Rivers of New South Wales

The rivers of New South Wales belong to four groups, which may be arranged according to the following table, with the areas of the basins and the rainfall according to H. G. McKinney:[1]—

		Area of Basin in square Miles.	Mean Rainfall in Inches.
The Rivers of the Coastal District—			
Richmond	2,660		31·88
Clarence	8,340		36·13
Macleay	4,200		31·20
Hunter	8,300		27·42
Hawkesbury	8,400		34·26
Shoalhaven	2,840		39·55
Hastings, Manning, Clyde, Moruya, Bega, Towamba, and other minor coast basins	15,360		41·69
Total area of coast basins		50,100	35·31

[1] H. G. McKinney, "Rivers of New South Wales," *Rep. Austral. Assoc. Adv. Sci.* vol. i. (1889), p. 406.

		Area of Basin in square Miles.	Mean Rainfall in Inches.
Brought forward		50,100	35·31
Murray System—			
Darling basin in New South Wales		128,170	16·17
Darling basin in Queensland	[103,650]		
Murray in New South Wales		51,670	17·35
Drainage to Southern Ocean—			
Snowy River		3,360	34·41
Basins of internal Drainage—			
Mirool and other Creeks	14,380		16·92
Lake George	490		25·82
Manara	33,970		12·83
Yantara	22,050		8·56
Tara	6,040		9·21
		76,930	
Total area of New South Wales as thus calculated		310,230	18·66

The coastal rivers include a series of comparatively short, disconnected rivers, which rise in the eastern part of the New South Wales Highlands, and flow across the coastal districts to the Tasman Sea. The rivers of the second group flow westward down the western slope of the Highlands, and all join the Darling-Murray system. The eastern rivers rise on the Highlands, across which they flow through broad, old valleys. They plunge over high waterfalls, into deep gorges, along which they rush in tumultuous rapids. These gorges have been cut far back into the eastern border of the tableland, which has been converted into an irregular, complex mountainous country. The banks beside the rivers are richly timbered, owing to the abundant rainfall, which is carried in by the winds from the ocean. After a torrential course, the rivers emerge on to the coastal districts; they flow across them through wide valleys, as deep streams, which are often navigable by ocean-going steamers many miles from the mouth. The rivers collect abundant silt and

mud, formed by the erosion of the upper part of their valleys; this material is carried across the coastal districts, and is deposited as soon as the flow of the river is checked by its entrance to the sea. Accordingly most of the eastern rivers have deltas of small islands, or their mouths are barred by shoals or sandbanks. These banks are cut through by every flood; but the material is redeposited, perhaps in a slightly different position, as the flood subsides. When a flood from the mountains arrives at the same time as a heavy fall of rain in the lower part of the valley, the river, barred at its mouth, is unable to discharge the water with the necessary rapidity, and the low-lying land is submerged. Thus the great flood of the Hunter basin, in 1893, converted the district between West Maitland and Newcastle into one vast lake. These floods, however, are useful, as they deposit layers of rich silt, so that the flood-plains on the lower part of these coastal rivers have very fertile soil. Moreover, the rainfall in the coastal district is ample, the average amount along the coast being $35\frac{1}{3}$ inches a year. The temperature is warm, and in the northern part of the country the climate on the low grounds is subtropical. Hence the vegetation is extremely luxuriant, and the lower basins of the four northernmost rivers, the Richmond, the Clarence, the Macleay, and the Manning, flow through dense forests and jungles of a tropical character. The gum trees in the forests yield valuable wood, so that the timber industry is important along these valleys. When the forests are cleared, the land beside the rivers is of high agricultural value, yielding rich crops of sugar, grain, and maize. The basins of the rivers in southern New South Wales are under less tropical conditions, as they are nearer high mountains, which are snow-covered in winter, and they are much

farther south. The palms, which are especially conspicuous along the northern coasts of New South Wales, still occur, however, in sheltered positions, as far south as Cape Howe.

Most of the coastal rivers flow in a fairly direct course from the Highlands to the sea, and are consequently comparatively short. But the Clarence, the Hunter, the Hawkesbury, and the Shoalhaven are longer, and drain more extensive areas. The Clarence, the Hawkesbury, and the Shoalhaven owe their greater length to the fact that, in their upper parts, they run north and south, parallel to the coast. The Clarence River is 240 miles in length, and its basin is 8340 square miles in area. It is navigable for 70 miles from its mouth. It is formed by three main tributaries. They are (1) the Upper Clarence, which comes southward from the Queensland frontier, and receives the eastern drainage of the Barney Downs; (2) the Mitchell, which comes from the south and receives, through the Aberfoyle River and the Guy Fawkes River, the drainage from some basalt-capped plateaus, including the Snowy Range, on the eastern edge of the Highlands, and from the Macleay Range; (3) the Nymboi also comes from the south, to the east of the Mitchell River. The north and south course of the three head branches of the Clarence is determined by the general north and south strike of the rocks in this part of the New South Wales Highlands.

The Hawkesbury River is composed of four main branches, the three longest of which run parallel to the coast. The longest is the Wollondilly, which rises in the Highlands near Goulburn, and flows north-eastward parallel to the coast. It leaps over a series of waterfalls into a picturesque gorge, where it is joined by the Cox River, which drains the southern part of the Blue

Mountains. It subsequently unites with the second chief constituent of the Hawkesbury, the Nepean, which drains the western slopes of the Illawarra Range. Some of its tributaries rise within three miles of the shore. Below the junction of these two southern branches the river is known as the Nepean, which receives the Grose River from the eastern face of the Blue Mountains, and then the Colo River, which comes down from the west-north-west, in continuation of the main lower valley. The river then receives the name of the Hawkesbury, and is joined by the Macdonald River from the north. The united rivers flow directly eastward to the sea at Broken Bay, from which the river is navigable by steamers for 70 miles, as far as Windsor.

The Shoalhaven River flows at first northward, parallel to the coast, between the Gourock and Currockbilly Ranges. Its course is determined by the ease with which the country is worn down along the strike of the soft Silurian rocks. After passing Bungonia, at a point 16 miles due east of Goulburn, it suddenly bends at right angles, and flows through a wide valley cut out of the Upper Marine Carboniferous series to the sea. As implied by the name of the river, there is a bar at its entrance.

The remaining coastal rivers of New South Wales flow, in the main, fairly direct from the Highlands to the sea. The chief rivers are the Richmond, which is 120 miles long, and drains a basin of 2660 square miles. It rises on the Queensland frontier and flows south-eastward to the sea; its basin is composed, in the main, of Lower Mesozoic rocks and shales. The Hunter River is the most important of the coastal rivers. It is 200 miles in length, and its basin is, according to McKinney, 8300 miles in area. It has a comparatively

simple course, running from its source in the Mount Royal Range east-south-east to the sea. It discharges through Port Hunter, on which is the town of Newcastle, the chief coal port of Australia. The Hunter is navigable to Morpeth, 35 miles from the sea. The upper part of the Hunter is known as the Goulburn. The direct east and west course of the Hunter is due to the fact that its basin is composed of the Permo-Carboniferous rocks which lie in the depression between the northern and southern tablelands. Its lower basin includes the chief coalfield of Australia.

South of the Shoalhaven is a series of smaller rivers, of which the chief is the Clyde (70 miles long), which flows from north to south, and then bending at right angles, enters the sea through Bateman's Bay. The other southern rivers are the Moruya, the Tuross, the Bega, and the Towamba, which enters Twofold Bay.

The Snowy River does not belong to the east coast series, although it drains a wide tract of country on the eastern slopes of the Highlands, for it discharges into the Southern Ocean, after an extremely sinuous course of 250 miles. The Snowy River begins at Mount Kosciusko, and first flows northward, as if it intended to reach the Murrumbidgee; it then turns easterly and then southward, and then south-westward, and crosses the New South Wales border into Victoria east of Forest Hill. The plains at its mouth, near Orbost, are extremely fertile.

Dalgety, the site proposed by the Federal Parliament as the capital of the Australian Commonwealth, is on the banks of the Snowy River.

The western river system of New South Wales belongs to the Murray. The Murray, as previously stated, is a compound river, composed of three main constituents, the Darling, Murrumbidgee, and Hume or Upper Murray.

Most of the basin of the Darling, and all that of the Murrumbidgee, are in New South Wales. The farthermost tributary of the Murray is the Condamine in Queensland, the source of which is said to be 3800 miles from the mouth of the Murray. The most important of the head-streams of the Darling is the Dumaresq, which rises in the northern Highlands of New South Wales. Its various head-streams drain the northern districts of New England from Tenterfield to the Queensland border. The Dumaresq forms the frontier between New South Wales and Queensland. It unites with the Macintyre, which drains the Beardy Plains of the New England Plateau from Emmaville to the south of Glen Innes. The two rivers continue as the Macintyre, which forms the inter-state boundary as far as 149° E. and 29° S.; thence the river strikes south-westward into New South Wales. The next chief tributary is the Gwydir, which rises in the same district as the Macintyre, but flows westward instead of northward. Below the junction of the Macintyre and the Gwydir the river is known as the Barwon, which, through the Namoi, receives the drainage from the northern slopes of the Liverpool Ranges and the hills about Coonabarabran. The Barwon is joined by the Castlereagh and the Macquarie, both of which flow, for most of their course, over the wide western plains. The Barwon flows almost due westward, and is joined by the Bogan, which flows along the boundary between the Lower Palæozoic rocks of the Cobar mining-field and the Cainozoic Plains to the east. Below Bourke the name of the river is changed from the Barwon to the Darling, which is joined from the north by the Warrego. This river generally consists of a series of disconnected pools, but it sometimes carries to the Darling some flood waters from Queensland. The Paroo, which comes from Queensland

on a course parallel to the Warrego, is lost on the plains. The Darling flows south-westward past Wilcannia, and bending southward past Menindie, joins the Murray at Wentworth. In the lower part of its course it receives no tributaries, and it flows between high banks, which have been raised above the level of the surrounding plains; so that in times of flood the water pours over the banks and spreads across the adjacent country.

South of the Darling basin is that of the Lachlan. This river rises in the Highlands to the north of the towns of Goulburn and Yass, and flows north-westward past Forbes and enters the Western Plains; it continues westward past Condobolin, and bending south past Hillston, joins the Murrumbidgee below Oxley.

The Murrumbidgee (a native name meaning beautiful river) rises in the mountainous country round Kiandra. Some of the tributaries of the Murrumbidgee rise only 40 miles in direct line from the Tasman Sea, and the Eumerella is the nearest of the Murray sources to the eastern coast of Australia. The Murrumbidgee discharges the spring floods formed by the melting of the snows on the Muniong Mountains. The Murrumbidgee enters the western plains in a deep channel; but its high banks gradually become lower as the river flows westward, until west of Hay the surrounding district is flooded when the river is high. Between the confluences of the Murrumbidgee with the Lachlan and the Murray the country beside the river is so low as to be flooded two years out of three. The soil depends thereon for its agricultural value.

The Tumut River, a tributary of the Murrumbidgee, rises near Kiandra, where, owing to the zig-zagging of the divide, the drainage now goes southward into the

Snowy River; but it originally flowed northwards into the Murrumbidgee. The Tumut has along its banks some of the richest agricultural lands in Australia. The Edwards River, in the Riverina, is only an anabranch of the Murray: it receives its water from overflows from the Murray below Cobram; but all of it is thrown back into the Murray by the raised flood-plains of the Murrumbidgee.

6. The Geology of New South Wales

New South Wales consists geologically of a vast block of ancient rocks, the main mass of which is of Lower Palæozoic age, associated with some Archean rocks. These old rocks once extended in an unbroken belt, north and south from Queensland to Victoria, across the eastern half of the State. The rocks in this vast block strike from north to south, as they have been crumpled into a series of folds by earth-movements from east and west in Upper Palæozoic times. The weak areas produced by these folds were invaded by vast masses of granitic rocks, which have altered the Lower Palæozoic rocks, and sometimes also the Upper Palæozoic rocks, with which they came in contact. This block of Lower Palæozoic rocks, which no doubt once extended continuously across the whole eastern half of New South Wales, has been divided into two parts, in Middle Palæozoic times, by the great valley now occupied by the basin of the Hunter River. This basin was filled with Carboniferous sediments, which were deposited upon the upturned edges of the older rocks; and in contrast to the predominant north and south strike of the older rocks, these Carboniferous beds strike from east to west. Thus, as Carne tells us, the marine Carboniferous rocks of

Cape Hawke have a strike of only one degree from east and west.[1]

The earth-movements in Devonian times must have produced a lofty mountain chain running north and south across New South Wales. The mountains, no doubt, rose many thousands of feet higher than the plateau which now occupies their site. The summits were clad in perpetual snow, and glaciers flowed from the snow-fields on the upper slopes down their flanks into the valleys, and probably discharged icebergs into the Australian seas; for some of the glacial deposits, which are amongst the most interesting of the Carboniferous system, are of marine origin. The chain of folded mountains was once continuous throughout New South Wales, from the Victorian frontier on the south to the tin-field of New England on the north. But the mountains have been worn down into a belt of Highlands, and even the old rocks of the mountain stumps have been divided into two distinct areas by the Carboniferous rocks of the Hunter basin, which cross the divide into the valley of the Talbragar.

The Lower Palæozoic band sometimes reaches the eastern coast, but is generally separated from it by the Upper Palæozoic and Mesozoic rocks of the coastal districts. It sends out numerous branches north-westward, of which the most important forms the great expanse of old rocks about Cobar, of which the north-eastern limit is formed by the Bogan River. Isolated ranges, such as the Rankine Range, which are formed either of Lower Palæozoic or Devonian rocks, occur as far west as the Darling River; and, in the far west of the State, occurs an outcrop of the ancient rocks, which

[1] J. E. Carne, "Notes of the General and Economic Geology of the Coast between Port Macquarie and Cape Hawke," *Records Geol. Surv. N.S.W.* v. pt. ii. p. 55.

build up the great plateau of Central Australia. The outcrop of the old Archean and Lower Palæozoic rocks can be recognised on any map showing the distribution of metalliferous minerals in New South Wales; for all the chief ores of the State occur in them. Thus the copper-field of Cobar and the great mining-field of Broken Hill are both on outcrops of the older rocks.

The Archean rocks, which are so important in the other States of Australia, are comparatively sparsely developed in New South Wales. They are sometimes not recognised, and the geological sequence is represented as beginning with the rocks grouped together as Silurian. Amongst the rocks assigned to the Silurian there must be many of older age. Thus in the Wyalong Goldfield the sedimentary rocks are assigned to the Silurian in accordance with "the practice," as Watt remarks, "thus to call provisionally large areas of rocks in the western portion of the colony, which as yet have furnished no fossil evidence as to their age." [1]

The pre-Silurian and Silurian rocks appear, however, to be so folded together, that only a detailed survey will fully unravel them.

The Archean system is represented in the southern part of New South Wales by gneisses and schists, which are a prolongation of the great metamorphic block of north-eastern Victoria, which has been shown to be, no doubt, of Archean age. At Broken Hill, in the Barrier Ranges, there is another wide extent of rocks, which are probably of Archean age, though the only available evidence is that of their lithological characters. In various parts of New South Wales there are outcrops of

[1] J. A. Watt, "Report on the Wyalong Goldfield," *Min. Res. N.S.W.* No. 5, 1899, p. 13.

schists; such are the mica-glaucophane schists described by White, from the northern part of the New England Plateau; also the hornblende schists described by Jaquet,[1] from Berthong, 20 miles north-east of Cootamundra, which, according to him, show a foliation, due to dynamo-metamorphism. Jaquet has also described some old slates containing platinum which occur at Fifield, 54 miles north-west of Parkes. He attributes them doubtfully to the Silurian; they underlie sandstones and limestones which are Devonian or Silurian. It is probable that many of these schists are outcrops of the Archean system; but some of them, such as the Ottrelite phyllites of Sofala described by Card,[2] are Palæozoic beds altered by granitic intrusions. Some of the granites in the extreme south of New South Wales are possibly of Archean age. But there is no doubt that the majority of the granites were intruded in Upper Palæozoic times. Thus the well-known granites along the southern coast of New South Wales have been shown by W. Anderson to alter the adjacent porphyrites, and to be later than the Upper Silurian;[3] they are earlier than the Devonian conglomerates, so they are probably of Lower Devonian age like many of those in the eastern part of Victoria. Other granites, such as those of the Swamp Oak Goldfield,[4] east of Tamworth, have altered Carboniferous mudstones.

[1] J. B. Jaquet, "The Intrusive and Metamorphic Rocks of Berthong, Co. Bland, New South Wales, with especial reference to the occurrence of Serpentine after Amphibolite," *Records Geol. Surv. N.S.W.* v. pt. i. 1896, p. 19, Pl. II.

[2] G. W. Card, "Ottrelite phyllite from Wattle Flat," *ibid.* v. pt. i. 1896, p. 31.

[3] W. Anderson, "General Geology of the S. Coast, etc.," *ibid.* ii. pt. iv. pp. 154, 164.

[4] G. A. Stonier, "Geological Notes on the Swamp Oak and Niangala Goldfields," *ibid.* vol. iii. 1892, p. 64.

Cambrian rocks are not known to occur in New South Wales. The Ordovician system appears to be fairly well represented, though its rocks have not yet been adequately separated from the Silurian. Their presence was first established by W. S. Dun, from the discovery of Graptolites at Tomingley, in the Peak Hill district,[1] 33 miles south-west of Dubbo. He recorded there the presence of Climacograptus and Dicellograptus, and identified the beds as of Lower Silurian (*i.e.* Ordovician age). His generic determinations have been confirmed by Mr. T. S. Hall.[2] Other graptolites have been found near Orange, at Mandurama (where the evidence of the graptolites as to age is less decisive, but whence Pittman has recorded an *Agnostus*), and in several localities along the Victorian border. Dun has also recorded Ordovician graptolites from Lyndhurst, on the Belubula River, eight miles west by south from Carcoar; and also in the county of Wellesley on the Victorian frontier.[3] The graptolite fauna is decisive that the rocks in which it occurs are of Upper Ordovician age, and this system is therefore widely distributed through New South Wales.

The Silurian rocks are the most important element in the geological foundation of New South Wales. They are very widely distributed. They consist mainly of sandstones, shales, and quartzites. They are associated with numerous masses of limestone, which will in the future be of great economic value.

The Silurian beds have been thrown into sharp folds, the axes of which strike from north to south. Some

[1] W. S. Dun, *Rec. Geol. Surv. N.S.W.* v. pt. iv. 1898, p. 183.

[2] T. S. Hall, *ibid.* vii. pt. ii. 1902, p. 49.

[3] W. S. Dun, "The Occurrence of Lower Silurian Graptolites in New South Wales," *ibid.* v. pt. iii. 1897, p. 124.

saddle reefs, such as those described by Watt[1] in the Hargraves Goldfield, occur in the folded areas. The Silurian beds are often very fossiliferous and have yielded a rich and interesting fauna. The limestones are full of corals; the shales yield many trilobites, especially in the Bowning beds, and the sandstones contain many brachiopods.

Beds of chert, largely made up of radiolaria, also occur in this system. The Silurian limestones are famous for magnificent caves, which have been formed by the solution of the rock by underground streams. The most famous are the Jenolan caves,[2] to the west of the Blue Mountains; others occur at Yarrangobilly, and at Bungonia, to the east of Goulburn.

The Devonian system is sharply separated from the Silurian by a marked unconformity; but from the resemblance between the faunas of those systems, some beds, of which the fossils are not well known, are of uncertain age, and are described as Devono-Silurian. The Devonian beds are mainly found in the western part of the State, where they form a series of ranges rising above the Western Plains. Such, for example, are the Cocoparra Range, between the Lachlan and the Murrumbidgee, and the Rankine Range, near Kallara, on the Darling. Fossiliferous Devonian boulders occur in the Cretaceous rocks on the opal-field of Wilcannia, and must have come from another of these western outliers. There are extensive areas of the Devonian rocks to the south-east of Goulburn near Newmonge, and to the west in the Boor and Avra Hills. The best known Devonian outcrops are those in

[1] T. A. Watt, "Saddle Reefs at Hargraves," *Rec. Geol. Surv. N.S.W.* vol. v. pt. iv. 1898, p. 153; and "Further Remarks on the Saddle Reefs of the Hargraves Goldfield," *ibid.* vi. pt. ii. 1899, pp. 83-107.

[2] A good description is given in an official handbook by Trickett.

the Blue Mountains, north of Rydal, where, as at Mount Lambie, the Devonian sediments are said to be 10,000 feet thick. Devonian sandstones are also seen along the Cox River, and on the slopes of Mt. Canoblas.

The Devonian rocks at Yalwal contain two types; the lower series consists of acid lavas (rhyolites), basic lavas and dykes (dolerites), and metamorphic and folded rocks. These rocks were regarded by Clarke as Silurian, but are assigned by Andrews to the Devonian. They present certain resemblances to the Lower Devonian of Victoria. The upper series at Yalwal consists of shales, grits, and soft tuffs containing *Lepidodendron*, so that they may be safely regarded as either Upper Devonian or Lower Carboniferous.[1]

Other Devonian outcrops occur in the extreme south-east of New South Wales, where they appear to represent both the Upper and Lower Devonian series of Victoria. Thus at the head of the Genoa River, near the Victorian border, there is a series of Devonian sandstones, containing *Archæopteris howitti* and *Sphenopteris carnei*, which indicate the Lower Devonian age of the beds. The Upper Devonian marine beds include the sandstones with *Rhynchonella pleurodon* at Eden and Twofold Bay, where this fossil was collected by Carne (1897).

The deposition of the thick series of Devonian sediments was stopped by earth-movements which ushered in the Carboniferous period. The Carboniferous system of New South Wales is of great importance, owing to its rich series of coal-seams, which promise to make the district from the lower Hunter River to Sydney the manufacturing metropolis of Australia. The coal-seams

[1] E. C. Andrews, "Report on the Yalwal Goldfield," *Min. Res. N.S.W.* No. 9, 1901, p. 16.

do not occur only where the Carboniferous beds occur on the surface; but they extend southward from the Hunter, under the Hawkesbury Sandstone, and occur below Sydney at the great, but still easily accessible depth of 3000 feet. The deep bore put down at Cremorne Point, on Sydney Harbour, to a depth of 3095 feet, proved the presence of the coal-seams under Sydney, including one seam of coal 10 feet thick.[1] A shaft has now been sunk at Balmain to work these coals.

There appears to be no sharp line of separation in New South Wales between the Carboniferous rocks and those of the period which, in Europe, is generally separated as a distinct system under the name of the Permian. The uppermost Palæozoic rocks of New South Wales are therefore described as the Permo-Carboniferous. The Permo-Carboniferous rocks cover an area of from 24,000 to 28,000 square miles, and they are economically the most important, as they contain all the coal that is worked at present in New South Wales.

The Lower Carboniferous beds occur mainly between the Hunter and the Manning Rivers. They consist of conglomerates and sandstones, interstratified with beds of shales and limestones. The sandstones contain the fossil land-plant *Lepidodendron* (*Bergeria*) *australe*, M'Coy. It is also found in Victoria and Queensland, so that all through Eastern Australia the Carboniferous system begins with a series of terrestrial deposits, characterised by the presence of Lepidodendron.[2] The Lower Carboniferous rocks are associated with sheets of contemporary

[1] David and Pittman, "Coal under Cremorne," *Rec. Geol. Surv. N.S.W.* iv. pt. i. 1894, p. 5. For later details, see Pittman's *Min. Res. N.S.W.* 1901, pp. 317-318.

[2] R. Etheridge, jun., "*Lepidodendron australe*, M'Coy. Its Synonyms and Range in Eastern Australia," *Rec. Geol. Surv. N.S.W.* ii. pt. iii. p. 119.

lava, and beds of volcanic ash, some of which have been shown by Professor David to contain copper ores. The Lower Carboniferous series also includes great masses of granite and granodiorite, which have altered the adjacent Devonian quartzites, slates, and conglomerates; and both the folded Devonians and the granites had been planed down before the deposition upon them of the Upper Marine beds of the Permo-Carboniferous. This arrangement is well shown at the Yalwal Goldfield,[1] where the gold occurs in thin veins of quartz ramifying in all directions, through both sediments and acid lavas (rhyolites) of Devonian age.

Other outcrops of these Lower Carboniferous rocks occur along the Cox River, south of the Blue Mountains, and along the Capertee River, and along the western flank of the Blue Mountains from Lithgow to Capertee. A band of the Lower Carboniferous rocks skirts the western flanks of the New England tableland, from the Macintyre River on the Queensland border, southward past Ashley, through the Bingara Goldfield, and past Lambeth, till it joins the main Lower Carboniferous outcrop between the Manning and the Hunter Rivers.

The Permo-Carboniferous rocks occupy an area of 24,000 to 28,000 square miles. They are exposed along the coast from Port Macquarie to Newcastle, where they disappear beneath the Hawkesbury Sandstone, which extends southward along the coast past Sydney to Wollongong. They reappear along the coast around Lake Illawarra, and from the Shoalhaven River to Bateman's Bay. From the coast as a base, the Permo-Carboniferous beds extend westward in a somewhat

[1] E. C. Andrews, "Report on the Yalwal Goldfield," *Min. Res. N.S.W.* No. 9, 1901, map, section C-D.

triangular area, of which the apex is west of the divide in the basins of the Castlereagh and the Macquarie Rivers. Rocks of this system occupy most of the basin of the Hunter River, and they also underlie the basin of the Hawkesbury. They are exposed by the gorges of the Capertee and Cox Rivers in the Blue Mountains, and along the western flanks of the Blue Mountains from Lithgow to Capertee.

Professor David has classified the beds as follows:—

	Thickness. Feet.
1. Upper or Newcastle Coal-measures, containing an aggregate of about 100 feet of coal	1,150
2. Dempsey Series; freshwater beds, containing no productive coal. This series thins out completely in some directions	2,000
3. Middle, or Tomago, or East Maitland Coal-measures, containing an aggregate of about 40 feet of coal . .	570
4. Upper Marine Series; specially characterised by the predominance of the fossil *Productus brachythærus* . .	5,000
5. Lower or Greta Coal-measures, containing an aggregate of about 20 feet of coal	130
6. Lower Marine Series; specially characterised by the predominance of the fossil *Eurydesma cordata* . .	4,800
	13,650

The characteristic plants of this period are *Glossopteris*, *Vertebraria*, *Nœggerathia*, and *Gangamopteris*. *Gangamopteris* is typical of the Lower or Greta coal-measures. The marine deposits associated with the Permo-Carboniferous series yield rich faunas of marine molluscs and other fossils.

Associated with the coal-measures is a series of glacial conglomerates containing boulders which have been unquestionably scratched and transported by ice. Some of these boulders are encrusted by marine organisms, so that they must have been actually laid down in the sea.

Hence some of the glacial beds of New South Wales, unlike the contemporary glacial deposits of Victoria, were, no doubt, carried by icebergs.

The glacial beds have been described by Mr. E. J. Dunn[1] as ranging as far north as the Ashford Coalfield, on the evidence of some scratched quartzite pebbles; but Professor David and Mr. Pittman[2] regard these scratchings as not of glacial origin.

The abundant volcanic rocks associated with the Permo-Carboniferous beds are mainly sheets of basalt and augite-andesite; they probably flowed out as lavas, which occur with beds of tuff. Other igneous rocks associated with the coal-measures were intrusive into them in later times; such are the syenite massif at Mittagong, and the dykes of dolerite which cut through the coalfields into the overlying beds of the Hawkesbury series, and are therefore, no doubt, of Post-Triassic age. Leucite occurs in some of the Carboniferous basalts, and was first recorded in Australia by David, in 1887.

The Mesozoic deposits of New South Wales include representatives of the three constituent systems—Triassic, Jurassic, and Cretaceous. The rocks referred to the Trias are divided into three divisions:—

The Wianamatta Shales, equivalent to the Upper Clarence shales of Queensland.

The Hawkesbury Sandstones, equivalent to the Middle Clarence sandstones.

The Narrabeen Shales, equivalent to the Lower Clarence shales.

Some coals corresponding to the Clarence coals of

[1] E. J. Dunn, *Proc. R. Soc. Vict.* vol. x. (new ser.) 1897, p. 204.

[2] T. W. E. David and E. F. Pittman, *Rec. Geol. Surv. N.S.W.* vol. vi. pt. ii. 1899, p. 77.

Queensland occur in the Triassic series of New South Wales; but, so far, none has proved of sufficient economic value to be worked. The age of these beds has been taken as Triassic, and this is supported by the evidence of their fossil fish. Dr. Smith Woodward, in his Memoir on "The Fossil Fishes of the Hawkesbury Series at Gosford,"[1] says that their age is probably Keuper (Upper Trias), but may be Rhætic (Lower Jurassic). A later fish from the Hawkesbury Sandstone at Harrington was identified by A. S. Woodward as *Atherstonia*, and of Upper Triassic age.[2] Some of the invertebrates of this series are survivals from the Palæozoic fauna, such as the Silurian gastropod *Tremanotus*,[3] found in the Hawkesbury Sandstone at Sydney.

The fossil plants of the Hawkesbury series are quite distinct from those of the Palæozoic, in which *Glossopteris* is the most conspicuous genus. The *Glossopteris* flora has disappeared, and is replaced by such fossils as *Taeniopteris daintreei* and *Thinnfeldia odontopteroides*. These plants are regarded by Mr. Seward as of Lower Jurassic age. This view is supported by the discovery at Talbragar of fossil fishes, which, according to Smith Woodward,[4] are "not earlier than the Upper Lias, and may be referable to the Lower Oolites." These fish-beds also contain *Taeniopteris daintreei*, which shows that that species certainly existed in the Jurassic times. As

[1] *Mem. Geol. Surv. N.S.W.* Palæont. No. 4, 1890, p. 55.

[2] A. S. Woodward, "On *Atherstonia australis* and *Ctenolates avus*, two new species of Fossil Fishes from New South Wales," *Rec. Geol. Surv. N.S.W.* vii. part ii. 1902, pp. 88-89.

[3] R. Etheridge, jun., "The Invertebrate Fauna of the Hawkesbury-Wianamatta Series," *Mem. Geol. Surv. N.S.W.* No. 1, 1888, p. 15.

[4] A. S. Woodward, "The Fossil Fishes of the Talbragar Beds (Jurassic), *Mem. Geol. Surv. N.S.W.*, Palæont. No. 9, 1895, p. 26.

it also occurs in the Hawkesbury Sandstone, that bed is probably not earlier than the Keuper or Upper Triassic. The Talbragar bed has been shown by David and Pittman[1] to rest in an erosion hollow in the Hawkesbury Sandstone; they accept its age as probably Jurassic, and equivalent to the Ipswich series of Queensland and the Jurassic mudstones of Victoria. This bed represents the only certain occurrence of the Jurassic system in New South Wales.

The Cretaceous system is very widely developed in the western part of the State, where it underlies the silts of the Darling; and hills of "Desert Sandstone" are scattered over the plateau between the Darling and the South Australian frontier.

One occurrence of Upper Cretaceous beds in the coastal districts has been shown by Dr. Smith Woodward,[2] at Nimbin, on the Richmond River, on the evidence of a fossil fish (*Ctenolates*).

The Cretaceous beds are divided into two series—the Rolling Downs Formation, which underlies the Darling Plains, and is regarded as Lower Cretaceous; the "Desert Sandstone" is regarded as of Upper Cretaceous age. The Desert Sandstone contains the opal deposits of the White Cliffs and Wilcannia on the Darling. Their age is shown by the occurrence of Cretaceous fossils, including the reptile Cimoliosaurus, whose bones have been converted into precious opal.

The Cainozoic rocks of New South Wales are of subordinate importance, except in so far as the silts of the Darling-Murray Plains are of great agricultural value. The most striking fact about the Cainozoic deposits of New South Wales is the complete absence

[1] Introduction to *Mem. Geol. Surv.* p. xiii.

[2] A. S. Woodward, *op. cit.*, *Rec. Geol. Surv. N.S.W.* vii. pt. ii. p. 91.

of any marine deposits in the coastal district. Its long estuaries and valleys afforded abundant shelter for such deposits had they ever been formed. The only marine deposits are recent raised beaches, which occur at a height of a few feet above sea-level. The absence of the marine deposits, which are so abundant on the southern and western coasts of Australia, demonstrates that until quite recently the land of New South Wales extended far eastward; and therefore the present coast-line is of quite modern date. There are some Cainozoic marine deposits in the extreme south-west of the State, where one arm of the old inland sea of the Murray basin extended up the Darling into New South Wales. Thus specimens, found in bores in the Lower Darling Valley, prove the presence of marine deposits of Middle Cainozoic age, as shown by Etheridge,[1] from the occurrence of *Trigonia semiundulata.*

Cainozoic volcanic rocks are widely distributed in New South Wales, but there are no craters so well preserved as those of Victoria. The plug of an old volcano occurs in the Pennant Hills near Sydney, and denuded volcanic vents occur on the western flank of the New England Plateau. In some of them, as at Inverell, are boulders of eclogite, which have been regarded as the source of some of the diamonds in the New England diamond-field; but according to a recent report by Mr. Pittman,[2] the diamonds have been found *in situ* in a dolerite dyke at Oakey Creek. Extensive sheets of basalt occur on the tablelands of New South Wales, both in New England on the Liverpool Plains and in the Monaro Plateau at Kiandra. Much of the

[1] R. Etheridge, jun., "Trigonia semiundulata in New South Wales," *Rec. Geol. Surv. N.S.W.* iii. pt. iv. 1893, p. 115.

[2] E. F. Pittman, *Ann. Rep. Dep. Mines, N.S.W.* 1904, p. 137.

extreme fertility of New South Wales is due to the rich soils formed by the decomposition of these rocks.

The Cainozoic volcanic rocks include basalts and tachylytes[1] as at Bulladelah; analcite basalts[2] near Sydney; leucite basalts at El Capitan[3] and Lake Cudgellico[4]; and sodalite basalts at Bondi; and nepheline basalt in the Capertee Valley;[5] and also trachytes and rhyolites.

It is now finally established, by the work of David, Helms, and Pittman,[6] that small glaciers once existed on the summit of Mount Kosciusko and extended for 1500 feet down its slopes. The glaciated rock surfaces there are illustrated by the accompanying photograph by Mr. A. E. Kitson.

7. Economic Geography

The administrative divisions of New South Wales are based on the natural geographical and industrial divisions. Generally speaking, the coastal districts are best suited for agriculture, trade, coal-mining, and manufactures. The southern Highlands are suited for rearing cattle; the northern Highlands are better for sheep or farming, as the climate is milder; the Western Plains are used for pastoral purposes, raising sheep or cattle.

The State is divided into thirteen districts, the economic value of which is largely governed by their

[1] G. A. Stonier, *Rec. Geol. Surv. N.S.W.* iii. pt. iv. 1893, p. 118.

[2] G. W. Card, *ibid.* vii. pt. ii. 1902, pp. 93-102.

[3] David, *Min. Mag.* 1887, pp. 193-194; David and Anderson, *Rec. Geol. Surv. N.S.W.* i. pt. iii. 1890, pp. 153-172.

[4] G. A. Stonier, *ibid.* iii. pt. iii. 1893, p. 71.

[5] G. W. Card, *ibid.* vii. pt. ii. 1902, pp. 40-43.

[6] T. W. E. David, R. Helms, and E. F. Pittman, "Geological Notes on Kosciusko, with special reference to evidences of Glacial Action," *Proc. Linn. Soc. N.S. Wales*, 1901, pp. 26-74, Pl. III.-X.

Photo. *A. E. Kitson*

A SURFACE GLACIATED BY A GEOLOGICALLY RECENT GLACIATION, ON THE SUMMIT OF MOUNT KOSCIUSKO, N.S.W.

rainfall. The two largest districts, Albert and the Darling, are in the west and form more than one-third of the whole State; but owing to their arid climate the land is thinly occupied, supporting only one sheep to every eight to ten acres; and the annual rent is often only 2d. per acre. The chief settlements in the Darling district are around Bourke.

Wentworth, near the junction of the Murray and the Darling, in the extreme south-western corner of the State, has the advantages of richer pasturage, better water-supply, and cheap freight along the Murray.

The most valuable of the pastoral districts is perhaps the Riverina, between the Murrumbidgee and the Murray. Though in New South Wales its trade is mostly through Echuca to Melbourne. Much of the land is now being used for farming purposes, as it grows valuable crops of wheat.

The south-eastern tableland of New South Wales, the Monaro district, is a high, dissected plateau, and owing to its cold, severe climate is mainly used for rearing cattle.

The New England district, the great northern tableland of New South Wales, was formerly included in the solely pastoral regions, but owing to its mild climate it is now being cut up into farms.

The best agricultural districts of the State are in the northern coastal plains. The soil is rich, the climate moist and warm, and the river flats along the basins of the Macleay and Clarence Rivers yield rich crops of sugar, maize, and fruit. There has been a great development of the dairying industry in the same districts since the export of frozen butter.

New South Wales, until 1901, was a free-trade State, but after federation it necessarily adopted the protectionist policy of Australia.

Its chief industry is the pastoral, and wool is the most important product. New South Wales is the greatest wool-producing State in Australia, but the widespread destruction of sheep by the drought of 1901-2 has reduced the yield of wool. In December 1901 there were 41,858,000 sheep in the State, whereas in 1891 there had been over 60,000,000 sheep. At the end of 1902 the number had further fallen to 26,650,000. They had increased, however, by the end of 1903 to 28,656,501, and the flocks are rapidly growing. The wool yield of 1903 was 227,004,320 lbs. of the value of £8,593,150. The chief wool districts are on the Western Plains. The largest sheep station is at Tamworth, which in 1892 had over 1,500,000 sheep.

Wool production on the western stations is so cheap in good seasons that the profits then compensate for loss at other times.

Horses are bred and exported to India. The Indian nickname for a horse, a Waler, is derived from the supply coming from New South Wales. The number of horses in the State in 1903 was 458,014.

Cattle stations occur along the Highlands and in the western districts. The cattle are reared on native grasses and salt-bush. In the coastal districts dairy-farming has made rapid progress, the butter being made in the factories, of which in 1902 there were 528. The increase of the butter trade has greatly stimulated the establishment of small farms; and the total export of butter increased from 534,000 lbs. in 1891, to 10,276,594 lbs. in 1901. The number of cattle at the end of 1903 was 1,880,548.

The agricultural industry is of secondary importance. The main crop is wheat, which is mostly raised in the Riverina. Climatic conditions cause great irregularities

in the extent of the wheat cultivation. Thus the land under cultivation during 1901 was 1,500,000 acres. The amount had fallen to 1,279,000 acres on March 12, 1903, but had increased again to 7,561,111 acres in 1904, when the wheat harvest was 2,733,141 bushels. The average wheat yield is 9 bushels to the acre; it was only 1·2 bushels per acre in the season for 1902-3; but the good rains of 1903 led to the increased yield of 17½ bushels per acre. Maize is largely grown for fodder on the coastal districts of the north.

The other chief food-stuffs are oats, potatoes raised on the Highlands around Bathurst, and sugar-cane. But the yield of sugar is declining. There are extensive vineyards and orchards, especially of oranges, in the coastal district, and in the Murray Valley near Albury. The acreage of the vineyards is 7900, producing in 1903 1,086,820 gallons of wine, and 4213 tons of grapes for consumption as fruit. Bananas, pine-apples, and other tropical fruits are cultivated in the northern coastal districts. The chief orchards are near Sydney. The total extent of land devoted to fruit-growing is about 8500 acres.

Timber is hewn from the gum forests, especially in the Grafton district in the north-east and along the Murray.

Rabbits have been especially troublesome in New South Wales, and £1,500,000 have been spent in their destruction. The system adopted is the erection of long fences of wire-netting, and the destruction of the rabbits within the enclosed area. Nearly 20,000 miles of rabbit-proof fences have been erected. In some districts the rabbits are destroyed by poison laid along furrows; in others the rabbits are killed and frozen for export,

and this industry will, no doubt, keep them under control in districts within easy reach of the railways.

The total number of manufactories in New South Wales in 1902 was 3396, employing 66,000 hands. Two-thirds of the factories are in Sydney and its suburbs.

The mining industry is also of great importance, and New South Wales yields an exceptionally varied number of metals.

The most important mineral asset of the State is coal. The worked coalfields occur through an area of 24,000 square miles, including the districts around Newcastle and smaller areas to the south of Sydney. Deep bores have proved the existence of thick coal-seams under Sydney, greatly increasing the available coal resources of the State. New South Wales has unquestionably the largest coal supplies in the southern hemisphere. The quantity raised in 1902 was nearly 5,942,000 tons, valued (at 7s. 5d. per ton) at £2,206,600.

Kerosene shale occurs in the Blue Mountains to the west of Sydney. It is mined mostly in the neighbourhood of Hartley, and is used for the supply of gas and oil. The value of the quantity raised in 1902 was £60,000.

Gold is widely distributed through the Highlands, and the first discoveries of payable gold in Australia were made in the Sofala and Turon districts near Bathurst. The total raised since the opening of the industry in 1851 is over £50,000,000. Most of the mines are small, but they are very numerous, and widely scattered through the State. The largest quartz-mine in 1902 was at Wyalong in the Lachlan district, and it yielded 20,718 oz. The gold yield for 1903 was valued at £1,080,029. The amount of alluvial gold raised is increasing, owing to the employment of dredges.

The silver-lead mines are second to coal in importance; they are not numerous, but the yield of these metals is high, owing to the enormous output of the mines at Broken Hill. The Broken Hill Proprietary Mine is the largest silver-lead mine in the world. The mines there have also raised millions of tons of zinc; but it has not hitherto been used, owing to the difficulty of separating the blende (zinc sulphide) from the associated rhodonite. This difficulty has now been overcome.

Tin is worked in New England, in Vegetable Creek, Emmaville, and Inverell.

Most of the copper comes from the Cobar district, between the Macquarie and the Bogan Rivers. The amount raised in 1903 was 5631 tons, valued at £431,186.

Iron is largely distributed, but none of the ores are being used at present. The Government has arranged for the establishment of works for the smelting of native iron ores.

Small quantities of antimony come from Hillgrove, in the Peel and Uralla district. The total value mined up to the end of 1903, was £194,910.

Bismuth to the amount of £75,821 has been raised, mainly from Pambula.

Diamonds are obtained in the river valleys in New England, and have been found *in situ* in a dolerite dyke at Oakey Creek. The New South Wales diamonds are remarkable for their exceptional hardness.

Opal occurs at White Cliffs, north of Wilcannia, in the Darling district, and the mines there are one of the main sources of supply for the world.

Mineral Yield

The Mineral Yield for 1903 included :—

			Total raised to Dec. 31, 1903.
Gold	295,778 oz.,	value £1,080,029	£51,886,617
Silver, silver-lead, and zinc . .		,, 1,626,576	35,744,489
Copper . . .	5,631 tons,	,, 431,186	9,247,068
Tin	1,298 ,,	,, 125,893	11,105,152
Diamonds . .	12,239 carats,	,, 9,987	
Opals		about 100,000	816,599
Antimony			194,910
Coal	6,354,846 tons,	value 2,319,660	44,021,103
Kerosene shale . .	34,776 ,,	,, 28,617	2,058,987

8. Railways

The railway system of New South Wales at the end of 1904 included 3281 miles open to traffic. It is all on the 4′ 8½″ gauge, and the total cost for construction and equipment has been £42,288,517. The average cost of construction per mile has been £12,980. This high charge was due to many of the railways having been made in the early days, when the prices of labour and all imported materials were very high.

The railway system includes one long line which crosses the State from the Victorian frontier on the south, through Sydney, to the Queensland border on the north. It enters New South Wales from Victoria at Albury (534 feet), crosses the upper part of the Murrumbidgee basin, and then, turning eastward, runs along the Divide between the Murrumbidgee and the Lachlan. It crosses the Highlands of New South Wales, and runs north-eastward to Cullerin, the highest station in this district, 2395 feet; 20 miles further west is Goulburn, which is itself at the height of 2074 feet; thence the railway runs north-eastward across the main southern tableland of New South Wales, ranging in height up to

2331 feet at Exeter, whence there is a long and somewhat irregular descent to 67 feet above the sea at Sydney. The length of the line from Albury is 386 miles. This line is continued northward parallel to the coast, to Newcastle, 102 miles; thence the line to Brisbane turns inland up the valley of the Hunter River, which is crossed at Singleton. The railway then climbs on to the northern or New England tableland, being 2073 feet above sea-level at Ardglen, 1279 feet at Tamworth, and 3265 at Armidale. It crosses within a few hundred feet of the summit of Ben Lomond at 4473 feet, and continues past Glen Innes, 3520 feet, and Tenterfield, 2834 feet, to Jennings, the frontier station, which is at the height of 2875 feet, and 490 miles distant from Sydney. The line continues across southern Queensland to Brisbane, 723 miles from Sydney.

On the eastern or coastal side of this line there are three main branches. One goes southward to Tumut, on one of the tributaries of the Murrumbidgee; one from Goulburn goes through Queanbeyan to Cooma, the railway centre for the Monaro Plains — the southernmost tableland of New South Wales. A third line runs from Sydney along the coast, through Wollongong and the smelting town of Dapto, and goes past the Illawarra Mountains to Kiama and Nowra. The coasts of New South Wales are also served by an isolated line in the extreme north-eastern corner of the State; it connects Byron Bay with Lismore and Casino, on the Richmond River, whence it is to be continued southward to the Clarence River at Grafton.

The remaining railways of New South Wales run westward and north-westward from the main lines to the Western Plains. A branch railway goes along the Murrumbidgee valley from Junee Junction to Hay, and also

to Jerilderie and Finlay in the Riverina, near the Murray. Another branch runs to Wyalong on the plains between the Murrumbidgee and the Lachlan. The most important of the north-western lines is that which goes from Sydney across the Blue Mountains, through Bathurst and Orange, to Dubbo, and thence to the Darling River at Bourke. It sends off branches on the western plains to Brewarrina, Coonamble, and the copper-field at Cobar; and a line from Orange through Parkes to the Lachlan River at Condobolla. The old zig-zag on this line up the western face of the Blue Mountains, west of Penrith, has now been superseded by a tunnel. Bourke is 503 miles from Sydney. Its level is 350 feet above the sea, and the highest point traversed by the line is at Clarence, 88 miles from Sydney, where the height is 3658 feet. To the west of Clarence the line descends from the Highlands by a zig-zag to Eskbank.

9. Political Geography

The Government of New South Wales consists of a State Governor appointed by the Crown, and two Chambers of Parliament. The Legislative Council consists of sixty members, who are appointed for life by the Governor, on the advice of the Executive Council. The Legislative Assembly consists of ninety members, to which the number was reduced by the Revenue Act of 1904. The members of the Assembly are elected by manhood and womanhood suffrage, at intervals of not more than three years. The members of the Assembly have an allowance for expenses of £300 a year, with a free railway-pass and an annual supply of stationery.

The revenue and expenditure for 1904 was—revenue, £11,248,327, and expenditure, £12,110,678.

The public debt in June 1903 was £80,970,000, of which it must be remembered a large proportion has been spent in building railways and other reproductive works.

The population, according to the census of 1901, is 1,359,133. It was estimated in December 1902 as 1,405,450, of which 508,500 live in Sydney and the suburbs. The numbers include 10,974 Chinese, most of whom came in during the rush from 1878 to 1887; by that year they had increased to 15 per 1000 of the population. Further immigration was restricted after some friction with the Home Government, by the Act of 1888. This Act reduced the immigration from 1798 in 1887 to 1 in 1889. The Act was extended in 1896 to all other coloured races, whose entrance was further restricted in 1901 by the Commonwealth legislation on alien immigration.

The State system of education is conceived on broad, generous lines. It is controlled by the Minister of Public Instruction. Attendance at school is compulsory from the age of six to fourteen years. The fee for each child is 3d. pér week, with a maximum of 1s. for any one family, and children are conveyed to school on the railways free. The education given by the State is secular, but the ministers of any denomination are entitled to give religious instruction during school hours.

The chief educational institution is the Sydney University, which was established in 1852. It is secular, but three denominational colleges and a Woman's College are affiliated to it. The Free Library, Art Gallery, and the Museum are supported by the State, and are excellent. The Art Gallery has an annual fixed endowment, which has rendered it the best in the southern hemisphere. The Australian Museum has a

rich collection illustrating the natural history of Australia and the southern Pacific, and Australian anthropology. The Mines Department has a superb collection of New South Wales minerals. The Public Library is rich in manuscripts on the early history of Australia, and the catalogue of the Australian section is one of the best bibliographies of Australia. There is a good Technical College in Sydney, Schools of Mines at Bathurst and Broken Hill, and an excellent Agricultural College at Hawkesbury.

The factories, shops, and mines of New South Wales are under careful Government supervision, and the Industrial Arbitration Act of 1901 enforces the reference of any trade dispute to a Court of Arbitration. The Court can insist upon the members of a Trades Union being employed in preference to non-unionist labour. The Act is experimental. It was only passed for seven years; but it has already secured the quiet settlement of disputes which might otherwise have ended in strikes. There is no regular poor-law administration in New South Wales, but relief is given when needed. Thus the State arranges for the education of children who might otherwise be neglected, and may take full charge of them. Any person of 65 years or upwards, who has resided in New South Wales for twenty-five years, may claim a pension, which may amount to £26 a year.

The labour legislation regulates the hours of work in factories. Shops in ordinary trades are bound to close by one o'clock on one day of the week, at six o'clock on four days, and by ten o'clock on Saturday. Juvenile smoking is prohibited, and the sale of tobacco to any one under sixteen is prohibited.

The Government still holds large areas of Crown lands, much of which is available for sale at the price

of £1 per acre. Payment is spread over twenty or more years, but within three years of the conditional purchase the purchaser must have made various improvements, and he must reside on the land for ten years. The blocks of land that may be purchased under such conditions are limited to 640 acres in the eastern district, and 2560 acres in the Central Division. Land may be bought free of residence conditions, in quantities not exceeding 320 acres, at twice the above-quoted rates, and £1 per acre must be spent in improvements within five years. Unoccupied Crown land may be leased at the rental of not less than £1 per square mile. Pastoral lands in the western district may be leased for 28 years, with a reassessment of the rent every seven years, and a minimum rent of 2s. 6d. a square mile. Any land covered with scrub may be leased for 28 years free of rent in consideration of the labour spent in clearing it. Crown lands, to the amount of not more than 2000 acres per annum, may be sold by auction; and the average price in 1902 was £1 : 13s. per acre.

Land may also be taken up on the system of selection. The selector chooses a block, not exceeding 1280 acres. He must erect on it a dwelling-house, must reside on it, and may be required to drain, plant, or irrigate it; and after six years have expired he has to pay an annual rent of 2½ per cent of the value of the land. The object of this Act is to help those who wish to start as small working farmers. By an Act of 1902 blocks near towns may be set apart for co-operative artisan colonies. Each member is allotted a block of not more than ten acres, which is leased for 99 years at 5 per cent of its value. The Government may give a grant up to £50 for improvements on the block.

10. Towns in New South Wales

ALBURY (36° 6′ S. lat., 147° 0′ E. long.), on the north bank of the Murray River, at the height of 531 feet above sea-level. It is now best known as the frontier station in New South Wales on the railway between Sydney (351 miles distant) and Melbourne (190 miles). Owing to the difference of gauge in the lines, change of trains is necessary here. The connection of the railway systems of the two States was effected on June 14, 1883. The place is of historic interest, as Hume and Hovell camped here on November 17, 1824, under a tree, which is still standing. They were the first white men to enter Victoria from New South Wales. They crossed what they called the Hume River, in a punt made of canvas and the parts of a cart. The adjacent districts are mainly agricultural, raising grapes, tobacco, and cattle; there is also some mining in the Black Range and Bungowannah. The town is the commercial centre for the Upper Murray, coaches running along the valley to Jingellic, etc. The Murray is navigable to Albury in favourable seasons; the first steamer, under Captain George Johnston, reached it in 1855.

This town was one of the sites proposed for the Federal capital, its recommendation being its position on the frontier of the two States on the main railway line. The objection to it was its hot, dusty summer climate. The population is 5821.

ARMIDALE (30° 32′ S. lat., 151° 38′ E. long.) is 313 miles north of Sydney, on the main Northern Railway, where it crosses the Dumaresq Creek. It lies 3313 feet above sea-level, and enjoys a fine cool climate and a magnificent water-supply, which are its chief recommendations as one of the selected rival sites for the

Federal capital. It is near the Hillgrove Goldfield, including the Baker Creek Mine and the antimony mines of Gara; but the main industry is agriculture. The population of the district is 7800.

BATHURST (33° 24′ S. lat., 149° 37′ E. long., 2153 feet above sea-level) stands in a plain, surrounded by hills, on the south bank of the Macquarie River, 145 miles west of Sydney. The town was named after Lord Bathurst, who, as Secretary of State for War, was in charge of Colonial affairs when the town was founded in 1819. It is the principal city in the western district of New South Wales, and is the third city in the State, with a population of 9223. It has a good school of Science and Art, and a Technological Museum, and the Government experimental farm and orchard are in the neighbourhood. The chief industries are agricultural and pastoral, nearly a quarter of a million of acres are under cultivation, the chief crops being wheat, maize, barley, tobacco, and grapes. The district was an important mining centre in the early days of the Australian gold industry. Gold-mines are worked at Wattle Flat, Sofala, Hill End, Turon—the famous diggings of 1851; silver at Sunny Corner, and copper at Burraga and Cow Flat. Good statuary marble occurs in the district, from a block of which an Italian carved a figure which had some notoriety as an alleged petrified aboriginee.

BERRIMA (34° 19′ S. lat., 150° 22′ E. long.), near Moss Vale, is a mining district, 2300 feet above sea-level, in the Wollondilly district, on the main Southern Road, 85 miles from Sydney. The chief minerals are kerosene shale, of exceptionally good quality at Joadja, coal near Berrima, copper near Goulburn, and rich deposits of iron ore. The population of the district is 10,000.

BLACKHEATH is one of the favourite tourist resorts in the Blue Mountains. It is 3494 feet above sea-level, and 73 miles west of Sydney. The chief attractions are the waterfalls, which plunge over the edge of the plateau into the deep gorges below; the most famous is Govett's Leap, pouring over a cliff 520 feet in height. The smaller waterfalls are the Trinity Cascade and Evans' Look-Out. Coaches run thence to the Jenolan Caves. The population is about 800.

BOMBALA (36° 54′ S. lat., 149° 15′ E. long.), on the river of the same name, is the chief town in the south-eastern corner of New South Wales. It is situated in the highlands of Monaro, 324 miles from Sydney. Owing to its fine summer climate and its picturesque scenery, its ample water-supply, and its proximity to the sea at Twofold Bay and to the Victorian frontier, it was chosen by the Senate as the site for the Federal capital, which, according to the present plans, will be at Dalgety on the Snowy River, in the same district. Dalgety has the same advantages as Bombala and a less severe winter climate. The soil around Bombala is rich, and the country is taken up as farms and cattle stations. Gold is obtained from many small mines scattered through this district, of which the chief are at Delegete and Bendoc. Lead, silver, and copper occur at Quidong, but the output is still unimportant. Bombala is reached by train from Sydney to Cooma, and thence by coach (54 miles), or by steamer to Eden, on Twofold Bay. The population of the town is 986, and of the district 4700, including 63 Chinese.

BOURKE (30° 3′ S. lat., 145° 58′ E. long., 350 miles above sea-level), the chief centre in the northern part of the Western Plains of New South Wales, is 503 miles north-west by rail from Sydney. It is situated on the

southern bank of the Darling River, above a weir and lock. When the river is navigable, steamers can go down to Adelaide and up to Walgett. It is connected to Sydney by rail, and, owing to its position, has been described as the Chicago of New South Wales; and but for the losses caused by drought it would no doubt have become a city of much greater size. The adjacent country is occupied by sheep and cattle stations. There is an irrigation station at Pera, 10 miles away, and cultivation is carried on in other localities, where water is obtained from deep wells. The population is 2609.

BROKEN HILL (30° 58′ 13″ S. lat., 141° 20′ 32″ E. long.), the chief silver-lead mining-field in the world, is in the Barrier Ranges, in the extreme west of New South Wales, over 900 miles from Sydney, and near the South Australian border. Though in New South Wales, the route to it is from South Australia, and the mines are managed from Melbourne. Before the discovery of the mines the district was included in Mount Gipps sheep station, and was an arid waste. Now it is a well-built city, with a population of 27,500, and equipped with electric light, electric trams, and all modern appliances. The mines were pegged out by Charles Rasp in 1883, and the Broken Hill Proprietary Company founded in 1885, and up to the end of 1899 distributed £9,168,000 in dividends and bonuses. It is now promised a period of lengthened prosperity, owing to the possibility of profitably extracting the zinc from its ores. The zinc has hitherto been allowed to remain in the tailings' heaps, owing to the former impossibility of profitably separating it from the associated rhodonite. The Proprietary Company employs 5000 hands, including those at its smelting and refining works at Port Pirie, and coke works at Bellami. The capital of the mining industry

is estimated at £5,000,000, and the dividends paid amount to over £11,000,000. The mineral export for 1902 is as follows:—

Concentrates (silver-lead), £912,495; slimes, £30,121; zinc, £239; carbonates, £2548; copper, £1073; tin, £922; gold, £14,490; other ores, £110,299. Total exports, £1,237,250; and imports, £710,992. Broken Hill is the centre of a large pastoral district—camels being used for the transport across the arid plains. Water-supply is obtained from a huge storage reservoir on Stephen's Creek.

COOMA (30° 12′ S. lat., 149° 9′ E. long., 2657 feet above sea-level) is the railway terminus for the Monaro district, including Bombala and Dalgety, for the mining centres of Kiandra and Bushy Hill, and for Mount Kosciusko and the famous caves of Yarrangobilly (70 miles distant). The chief products of the district are cereals (wheat, barley, oats, rye, maize), and potatoes, butter, cheese and bacon. The population of the town is 1938, and of the district 15,200.

COONAMBLE (31° S. lat., 148° 28′ E. long.), on the Castlereagh River, is the chief town in the pastoral district of Castlereagh, and the terminus of a branch railway from Dubbo, 95 miles distant. It is 375 miles north-west of Sydney, and 70 miles from Walgett, the head of the navigable part of the Darling. Irrigation of crops has been undertaken by the artesian bore water on a fairly large scale. Its flowing well, 1302 feet deep, yields a supply of 2,000,000 gallons of water per day, which supplies the town, and some of it is used for irrigation. The population of the town is 1684, and of the district 6000.

COWRA (33° 52′ S. lat., 148° 45′ E. long.), on the Lachlan River, is 219 miles west of Sydney, on the

railway from Blayney to Harden. The chief produce is wheat, wine, and wool. Gold is found in the hilly country at some distance to the east and west of the town; copper at the Belmore copper-mines; iron and silver in the Broula Range. The population of the town is 1816, and of the district, 11,000.

DALGETY. *See* Bombala.

DENILIQUIN (35° 32′ S. lat., 145° 2′ E. long.), on the Edwards River, is the chief town on the fertile but often drought-stricken plains of the Riverina. It is the terminus of a railway which connects with the Victorian railways at Echuca, and it is thus more closely connected with Melbourne, 201 miles distant, than with Sydney, which is 484 miles distant. The nearest station on the New South Wales Railway is at Finlay, 37 miles distant. It is the chief coaching centre of the Riverina. The population of the town is 2645.

DUBBO (32° 18′ S. lat., 148° 35′ E. long., 865 feet above sea-level) is on the Macquarie River, 226 miles north-west of Sydney. It is on the railway to Bourke. Its water-supply is from a deep well. The chief industry is pastoral, but some crops are raised of maize, wheat, oats and fodder. The population of the town is 3410, and of the district 8300.

FORBES (33° 27′ S. lat., 148° 5′ E. long.) is the principal town on the Lachlan River, and one of the most important of the western towns. It is 289 miles west of Sydney, at the terminus of a branch railway. Its industries are agricultural and pastoral. The population of the town is 4313, and of the district between 6000 and 7000.

GLEN INNES (29° 45′ S. lat., 151° 46′ E. long., 3518 feet above sea-level) is the chief commercial centre of the plateau of New England, which is the richest area in

northern New South Wales. The town is 422 miles north of Sydney on the railway to Brisbane, which is 300 miles farther north; it is 110 miles from the coast. The soil is rich, yielding crops of oats (2,000,000 bushels a year). It is in the chief tinfield of New South Wales; Emmaville, the centre of the Vegetable Creek Tinfield, is 30 miles to the north-west. The district has yielded fully £7,000,000 of tin since the first discovery of the ore in 1872. Bismuth and molybdenite occur at Kingsgate. The population of the town is 3000, and of the district 9000.

GOULBURN (34° 45′ S. lat., 149° 45′ E. long., 2071 feet above sea-level), near the Wollondilly River, 134 miles south-west of Sydney, on the main railway to Melbourne, is the junction with the line for Lake George and Cooma. It is in an agricultural district, producing maize, barley, rye, oats, potatoes, butter, cheese, bacon and ham. The population is 10,612.

HAMILTON (32° 57′ S. lat., 151° 46′ E. long.), on the Hunter River, is a colliery town, and is now a suburb of Newcastle, from which it is two miles distant. The population is 6124.

HARTLEY, on the river Lett, 83 miles north-west of Sydney, is one of the chief centres of the kerosene shale industry. As much as 20,000 tons of shale have been produced in one year. The deposit at Hartley Vale is approaching exhaustion. The population of the town is 800, and of the district 9000.

HAY (34° 30′ S. lat., 144° 56′ E. long., 305 feet above sea-level), on the Murrumbidgee River, 454 miles south-west of Sydney, and the westernmost terminus of the New South Wales railway. It is connected by coach road with Deniliquin, and is an important centre for the sheep stations in the Riverina, and on the

Lachlan. There is an iron swing-bridge over the Murrumbidgee. The population of the town is 3012, and of the district 12,316.

ILLAWARRA (34° 30′ S. lat., 150° 40′ E. long.) is a fertile district to the south of Sydney, from Clifton to Shoalhaven. It consists of a strip of land about 40 miles long between the coast ranges and the sea. The district is well populated. The chief industries are dairying, with some coal-mining and ore-smelting at Dapto. The population of Central and North Illawarra is 7854.

INVERELL (29° 48′ S. lat., 151° 10′ E. long.) on the Macintyre River, 341 miles northward from Sydney, is an important centre of the New England district. Numerous lines of coaches start from Inverell to the outlying villages and stations, where tin-mining and some diamond-mining are carried on. The best Australian diamonds have come from this district. The population of the town is 3293, and of the police district 13,081.

LITHGOW (33° 35′ S. lat., 150° 31′ E. long.) is a township on the Great Western Railway line in the Blue Mountains in the district of Hartley, about 96 miles west of Sydney. It is 3006 feet above sea-level. Rich deposits of kerosene shale are worked in the district, and there are deposits of coal and iron ore. The population is 5268.

MAITLAND (32° 45′ S. lat., 151° 35′ E. long.), in the county of Northumberland, is situated on the Hunter River. The town has several times been almost destroyed by floods from the Hunter, as in March 1893. Maitland is an important railway junction, being connected by the Great Northern Railway to Newcastle and Sydney, and there are branch lines to the towns in the

north and north-west, and to Morpeth. Coal-mining is the chief local industry. The population of both East and West Maitland is 10,073.

MANLY (33° 50′ S. lat., 151° 17′ E. long.), 7 miles north-east of Sydney, is situated on the isthmus connecting the North Head of Port Jackson Harbour with the

NEAR MURRURUNDI.

mainland, and its beach is a favourite holiday resort from Sydney. The population is 5042.

MINMI (32° 40′ S. lat., 151° 38′ E. long.), on Minmi Creek, 89 miles north of Sydney, is a coal-mining township with a population of about 6500.

MURRURUNDI (31° 46′ S. lat., 150° 50′ E. long., 1546 feet above sea-level), on the Page River, 192

miles north-westward of Sydney, at the foot of the Liverpool Range. It is in the county of Brisbane. A big deposit of kerosene shale occurs 3 miles north. The population of the town is 1235, and of the district 7326.

MURWILLUMBAH, or KYNUMBOON (20° 15′ S. lat., 153° 31′ E. long.), in the county of Rous, 407 miles north of Sydney, is in a rich sugar-producing district, in the valley of the Tweed River. The population of the town is 1200, and of the district 30,000.

NARANDERA (34° 47′ S. lat., 146° 34′ E. long.) is an important town on the Murrumbidgee, which is here usually navigable for six months in the year. The town is 347 miles south-west from Sydney, and is a station on the South-Western Railway. The district is mostly pastoral, but also yields large crops of wheat and hay. Some gold is found. The aboriginal station of Warangesda, with a reserve of 600 acres, is 38 miles distant, and is now under direct supervision of the Government. The population of the district is 9194.

NEWCASTLE (32° 55′ S. lat., 151° 49′ E. long.) is situated at the mouth of the Hunter River, 62 miles by water and 102 miles by rail from Sydney. It is the principal coal port of Australia. The entrance to the harbour is dangerous during storms from the east-south-east, but it has been improved by an artificial breakwater. The population of Newcastle is 14,250.

ORANGE (33° 16′ S. lat., 149° 11′ E. long., 2843 feet above sea-level), in the counties of Wellington and Bathurst, is situated on Blackman's Swamp Creek, which has now been converted into a stone-lined artificial channel. It is 192 miles by rail west of Sydney. It is a favourite resort for holidays and invalids, owing to its bracing climate, and was therefore recommended as

a site for the Federal capital. The district is agricultural, growing wheat and fruit. The population of the town is 3990, and that of the district is 14,232.

PARRAMATTA (33° 46′ S. lat., 151° 1′ E. long.) is 14 miles west from Sydney, after which it is the oldest town in the State. It stands on the Parramatta River, near its entrance to Port Jackson. The name means "Head of the Waters." The chief local products are fruit, especially oranges and vegetables. The population is 12,560.

PEAK HILL (32° 33′ S. lat., 148° 49′ E. long.), on the Bogan River, 272 miles west from Sydney, in the county of Narramine, is an agricultural, pastoral, and mining township. Its population is 1107, and that of the surrounding district is 4300.

QUEANBEYAN (35° 20′ S. lat., 149° 15′ E. long.), in the county of Murray, on the river Queanbeyan, 194 miles south-west of Sydney, is the centre of a mining, pastoral, and agricultural district. The chief minerals raised are ores of copper, silver, lead, iron, manganese, and gold. The population of the town is 1219, and that of the district is 70,000.

RAMORNIE (29° 40′ S. lat., 152° 44′ E. long.) is situated on the Clarence River, 378 miles north of Sydney, in the county of Clarence, and has the factory of the Australian Meat-Preserving Company.

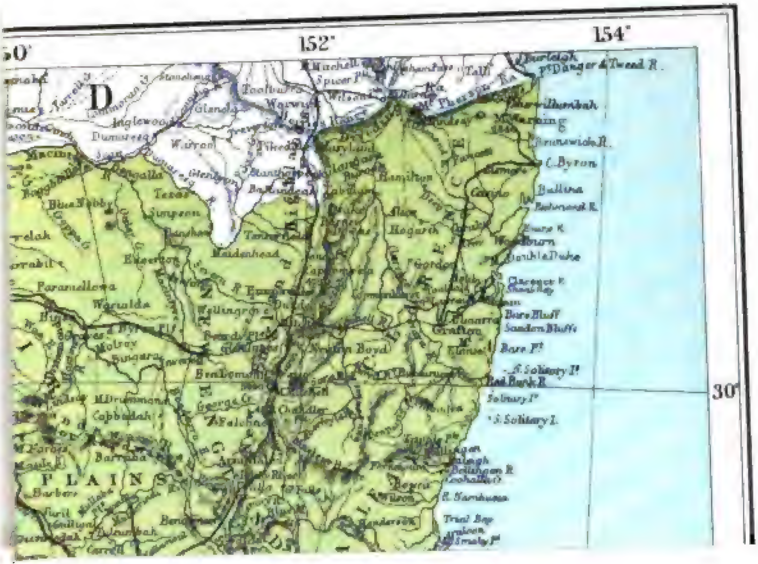
SINGLETON (32° 24′ S. lat., 151° 7′ E. long.), a coal-mining township, with a population of 5000, in the county of Northumberland, and is 147 miles north-west of Sydney.

SYDNEY (33° 51′ 41″ S. lat., 151° 11′ 40″ E. long.), the capital of New South Wales and the chief port of Australia, is picturesquely situated on the southern shore of Port Jackson Harbour. It is the oldest European

settlement in Australia. Its extensive wharfs and quays are 23 miles in extent, and will accommodate vessels of the largest tonnage. The city was named after Earl

TOWN HALL, SYDNEY.

Sydney. Vessels are guided to the harbour by a lighthouse on the South Head, which is one of the most powerful lights in the world, and can be seen 30 miles away. The streets are irregular in plan, and often



152°
154°
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D
Pt Danger & Tweed R.
Brunswick R.
C. Byron
Ballina
Richmond R.
Double Duke
Grafton
Bare Pt
Red Bank R.
S. Solitary I.
Trial Bay
PLAINS
Inglewood
Warwick
Texas
Maidenhead
Paramellowa
Warialda
Hamilton
Hogarth
Gordon
Dumaresq
Bingara
George Cr.

narrow. They have an excellent electric-tram service. The public buildings are numerous and commodious. The Australian Museum and the Sydney Art Gallery are the best in the southern hemisphere. There is a magnificent Public Library, rich in manuscripts on the early history of Australia. The University is one of the glories of the State. Coal has been proved to exist under Sydney, and works to mine the deposits are in progress. The population of the city proper in 1901 was 111,801; of the suburbs 370,052; of the shipping 6529; giving a total of 488,382. The population in January 1904 was estimated at 511,030.

TAMWORTH (31° 4′ S. lat., 150° 57′ E. long.), in the counties of Inglis and Parry, 282 miles north of Sydney, is an important railway centre on the Peel and Cockburn Rivers and the Goonoo-Goonoo Creek. The town is built on low ground, surrounded by an undulating plateau. The adjacent district is pastoral, agricultural, and mining. Gold and diamonds have been found in the district. The population of the town is 5799, and district 20,000.

WAGGA-WAGGA (35° 7′ S. lat., 147° 27′ E. long.), in the county of Wynyard, on the south bank of the Murrumbidgee, is a pastoral and agricultural town, 309 miles south-west of Sydney. It is on the main line from Melbourne to Sydney. The main industries are pastoral, agricultural, and gold-mining. The population is 5108.

WINGEN (31° 55′ S. lat., 150° 54′ E. long., alt. 1002 feet) is situated 204 miles north of Sydney, in the county of Brisbane, on the Kingdon Ponds Creek, a tributary of the Hunter. The district is agricultural, with deposits of coal and kerosene shale. Two miles from the town is the famous "burning mountain," which is said to

be due to the slow combustion of a coal-seam that has been set on fire. The population of the town is 120, and that of the district is 15,500.

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CHAPTER XII

QUEENSLAND

QUEENSLAND occupies the whole of the north-eastern corner of Australia. It projects to the north, between the Pacific and the Gulf of Carpentaria, as the York Peninsula, the end of which, Cape York, is separated from New Guinea only by the shallow Torres Strait. The Queensland coast-line is irregular, and is about 2250 miles in length. The State is bounded to the east by the Pacific, to the south by New South Wales, to the west by the Gulf of Carpentaria and the Northern Territory of South Australia. The length from north to south is approximately 1300 miles. The State has an area of 668,500 square miles, or nearly 428,000,000 acres. It is the third in order of size among the States of Australia.

Queensland was perhaps first seen by white men when Torres, in 1605, passed through Torres Strait on his return from de Quiros' expedition; but it was first reached by various Dutch expeditions working eastward from Java. They explored the Arnhem Peninsula of South Australia and the Gulf of Carpentaria. The eastern coast was first explored by Cook in 1770, but no settlements were effected in Queensland till 1823. The colonies there were known at first as the Moreton

Bay district of New South Wales; but at length, owing to the great distance from Sydney, and the marked geographical differences between this tropical State and New South Wales, it was separated as a new colony, under the name of Queensland, in 1859.

The geographical structure of Queensland is a direct expression of its geological structure. It may be divided into three areas. The most important division is occupied by the mountainous country of eastern Queensland, which extends from New South Wales northwards to the York Peninsula. This district is part of a tableland which once extended further eastward into the southern Pacific. The eastern part has foundered beneath the sea. The eastern slope of the highlands, facing the sunken area, is broken by steep scarps and cliffs; whereas the western slope is long and gentle, and passes gradually into the wide western plains. The second division consists of the Great Plains, which extend westward from the foot of the Queensland Highlands along the whole length of the State, from the Gulf of Carpentaria on the north to the border of New South Wales on the south. These open treeless plains have a rich soil, due to the decomposition of vast beds of clay which were laid down in a sea that once extended from the Gulf of Carpentaria southward to Lake Eyre.

The third geographical division of Queensland is in the far west, along the border of the Northern Territory of South Australia. It consists of the Barklay Tableland and the adjacent area of old rocks, which form the easternmost projection from the ancient plateau of Central and Western Australia. This plateau is due to the reappearance at the surface of the old rocks that form the foundation of the Queensland Highlands.

Queensland, therefore, consists of three main geo-

graphical areas. The Queensland Highlands on the east, forming nearly the whole of the eastern part of the State; the Western Plains; and part of the Archean Plateau of Central Australia.

The chief mountains of Queensland have been formed by the dissection of the tableland of eastern Queensland, which has an extremely irregular surface, due partly to earth movements, but mainly to denudation by rivers. The ridges left by denudation have been named as distinct mountain ranges; and the number of these ranges is legion. One series of them is grouped together under the name of the "Main Dividing Range" or "Great Dividing Range." According to some authorities, the "Great Dividing Range" extends north and south through the full length of Queensland from Cape York to the New South Wales border. According to others, the "Great Dividing Range," after zig-zagging northward and westward across southern Queensland, runs westward across the Western Plains to the South Australian border on the Barklay Plateau. The "Great Dividing Range" is, however, only the main divide or watershed. So long as it be understood that the term is intended solely to apply to a watershed, there is, perhaps, no great objection to its use; though the term has been regarded both in England and Australia as indicating the existence of a definite mountain chain. Most maps of Queensland show conspicuous evidence of this misleading influence of the term.

The so-called "Great Dividing Range" runs along the southern frontier eastward to Wilson's Peak, where it turns north-westward, and, after a course of 80 miles, turns due westward through Mount Horrible, and the outlier of the Desert Sandstone that forms Mount Combabule, and across the plateau of Desert Sandstone forming the divide

between the Dawson River and the Culgoa, and often marked as the Denham Range.[1] It then continues northward over a basalt plateau, through Mount Hutton, and the Buckland Tableland. It turns south-westward as far as a basalt outlier which Mitchell named Mount Pluto, and there turns abruptly to the north and crosses a tableland of Desert Sandstone, of which the part between the sources of the Barcoo and the Belyando Rivers is known as the Belyando Range. It is represented on many maps by a line of prominent hill shading, suggesting a narrow mountain range; whereas the country extends as widespread plains on which the "Great Dividing Range" is nothing but a barely perceptible watershed. After crossing the railway to Hughenden the "Great Dividing Range" bends abruptly southward to avoid the hills to the north, and runs westward across the plains, separating the upper tributaries of the Diamantina from the head-waters of the Flinders and the Gilbert. It leaves the open plains near Mount William, and again carefully avoiding the higher land, crosses the southward part of the Cloncurry Goldfield. It includes the Selwyn Range; and there bending northward, it again traverses much older rocks, and after crossing the Barklay Tableland, enters the Northern Territory of South Australia.

The "Great Dividing Range," therefore, does not include the chief mountain system of Queensland, and it frequently avoids the hills that might be expected to form part of it. It is only a watershed, the course of which is determined by many geographical accidents. The main Queensland mountains occur to the east of the Divide. They are sometimes called the East Australian

[1] *E.g.* by *The Times Atlas.* The Denham Range of the official Queensland Maps is the divide between the Suttor and Isaacs Rivers.

Cordillera, and sometimes the Queensland Coast Ranges. Both terms are inappropriate, because they are geographically different in structure from the Cordillera of South America, and they lie too far inland to be appropriately described as coast ranges.

The main mountain area of Queensland may be conveniently called the Queensland Highlands, for it in fact consists of a dissected plateau. The higher ridges and crests upon this plateau have been determined in some cases by earth-movements, but more generally by denudation.

The great majority of the mountain ranges of Queensland are ridges which separate valleys that have been hollowed out by river action.

The principal features described as the mountain ranges and their geological characters are given in the following list:—

1. The Line of the Great Divide

Barklay Tableland	19° S. & 148° E.	Rolling Downs Formation.
Wagga Boonyah Range (part of the Hugh Range)	20° S. & 139½° E.	Slates, Schists, etc.
Selwyn Range .	21° S. & 140° E.	Slates, Schists, and Granite.
William Range .	22° S. & 140½° E.	Slates, Schists, and Granite.
Kirkby Mountains	21½° S. & 141° E.	Rolling Downs Formation.
Belyando Range .	22° S. & 146° E.	Desert Sandstone.
Warrego Range .	25° S. & 146° E.	Desert Sandstone.
Buckland's Tableland	25° S. & 148° E.	Basalt.
Carnarvon Range .	25° S. & 148° E.	Gympie Formation.
Craig's Range .	27½° S. & 151° E.	Basalt.
Bunya-Bunya Range.	27° S. & 152° E.	Basalt.

2. Other Ranges

Bigges Range	25° S. & 149½° E.	Desert Sandstone.
Expedition Range	28° S. & 143° E.	Slates, Schists, etc., and Desert Sandstone.
Grey Range	28° S. & 143° E.	Slates, Schists, etc.
Dawes Range	24½° S. & 151° E.	Gympie Formation.
Burnett Range	24½° S. & 151½° E.	Gympie Formation.
Herries Range	28° S. & 151½° E.	Gympie Formation, and Granite, Porphyry, Trachyte, etc.
Grafton Range	26½° S. & 148½° E.	Basalt, Diorite, etc.
Drummond Range	23° S. & 147½° E.	Star Formation, and Slates, Schists, Greywackes, Quartzites, etc.
Denham Range	22° S. & 148° E.	Middle Bowen Formation.
Leichhardt Range	21° S. & 147¾° E.	Middle and Upper Bowen Formation.
Clarke's Range	20½° S. & 148° E.	Granite and Granitoid Rocks, Felspar and Quartz-Porphyry, Trachyte, etc.
Sea View Range	18½° S. & 146° E.	Granite and Granitoid Rocks, Felspar and Quartz-Porphyry, Trachyte, etc.
Gregory Range	20° S. & 147½° E.	Slates, Schists, Greywackes, Quartzites, etc.
Connor's Range	21½° S. & 149° E.	Granite and Granitoid Rocks, Felspar and Quartz-Porphyry, Trachyte, etc.
Boomer Mountains	23° S. & 150° E.	Gympie Formation.
Broadsound Ranges	22½° S. & 149½° E.	Gympie Formation.
Stokes Range	29½° S. & 141½° E.	Slates, Schists, etc.
Johnstone Range	24½° S. & 143½° E.	Desert Sandstone.
Moriarty's Range	28° S. & 145½° E.	Desert Sandstone.
Hood's Range, Walter's Range, Willie's Range	29° S. & 144½° E.	Desert Sandstone.
Macgregor's Range	27° S. & 142° E.	Desert Sandstone.
Coleman Range	26° S. & 142½° E.	Desert Sandstone.
Canaway Range	26° S. & 143° E.	Desert Sandstone.

Cheviot Range .	25° S. & 143½° E.	Desert Sandstone.
Beal Range . .	26° S. & 141° E.	Rolling Downs Formation.
Tully Range .	23½° S. & 142½° E.	Desert Sandstone.
Hamilton Tabletop	23½° S. & 141° E.	Desert Sandstone.
Kangaroo Mountains	23½° S. & 142° E.	Desert Sandstone.
Standish Ranges .	22° S. & 140° E.	Rolling Downs Formation.
Finucane Range .	22½° S. & 141½° E.	Rolling Downs Formation.
Sword Range .	22° S. & 141½° E.	Desert Sandstone.
Gregory Range .	18½° S. & 142½° E.	Desert Sandstone.
Grampian Hills .	20½° S. & 143½° E.	Rolling Downs Formation.
Macrossan Range .	13° S. & 143½° E.	Granite, etc.
Janet Range .	12½° S. & 143½° E.	Granite, etc.
Macilwraith Range	14° S. & 143½° E.	Granite, etc.
Wilkinson Range .	12½° S. & 142½° E.	Desert Sandstone.
Richardson Range .	11½° S. & 142½° E.	Desert Sandstone.
Sir Wm. Thompson Range	12° S. & 142½° E.	Desert Sandstone.
Bellenden Ker Mountains .	17½° S. & 145½° E.	Granite.
Lamb Range .	17° S. & 145° E.	Granite.
Sley Hills . .	17° S. & 145½° E.	Gympie Formation.
Basiuisk Range .	17½° S. & 146° E.	Slates, Schists, Quartzites, etc.

The course of the Queensland coast is independent of the geological structure of the country. It has been determined by the earth-movements that cut off the former eastern extension of the country. These movements traverse the country independently of its geological structure. Thus, in the Bowen Coalfield, the Middle Bowen beds have been let down by a fault trending from north-west to south-east against three groups of the older rocks, viz. the altered volcanic rocks of the Toussaint Range, the old schists and granites of the Clarke Range, and the Lower Bowen series on the flanks of the Broad Sound Range.

The Queensland Highlands consist of rocks of great geological antiquity, including ancient granites and Archean schists, various members of the Palæozoic group, and some coal-measures belonging to the Jurassic

System; and they are flanked by Cretaceous deposits which rest irregularly on the older formations. In the southern part of the State the rocks of the Highlands generally trend from north-west to south-east, being roughly parallel to the coast; but in northern Queensland they trend rather from east to west, and their course is inconsistent to that of the coast.

The Western Plains consist of rocks belonging to the Rolling Downs series. They were once covered by a broad sheet of Desert Sandstone, which has now been reduced by denudation to a number of isolated peaks, ridges, and tablelands. Many of these have distinctive names as mountain ranges.

The Queensland Highlands are well timbered owing to the abundant rainfall, but the vegetation is generally thin, except where the basalts and other volcanic rocks have decomposed to a rich soil, which supports forests of tropical luxuriance. The Western Plains yield a rich soil, but owing to the smallness of the rainfall the vegetation is scanty, and the country consists of open treeless plains. Their rich turf enables them, in good seasons, to support great herds of cattle; but the only trees are groves of Mulga and Gidya along the river courses.

3. The Geology of Queensland

The oldest rocks of Queensland are a series of gneisses and schists, which no doubt underlie the whole of the State. These rocks were regarded by Daintree as in part of Silurian age, owing to their lithological resemblance to the metamorphic rocks of Victoria, which were then regarded as composed of altered Silurian rocks; but it has since been shown[1] that the Victorian

[1] J. W. Gregory, "The Metamorphic Rocks of North-Eastern Victoria," *Trans. R. Soc. Vict.* vol. xv. (new ser.) 1890, pp. 123-131, pl. xix.-xxi.

rocks in question are at least pre-Ordovician, and are probably of Archean age.

The metamorphic rocks of Queensland include two different types of rocks, a lower series of gneisses, mica schists and hornblende schists, such as those of the lower series of the Cape Goldfield; so far as lithological evidence can be relied on, they are probably of Archean age. The upper series includes quartzites, schists, and slates, which form the upper part of the Cape Goldfield series. This upper division, judging from the descriptions of the rocks, may possibly include some Lower Palæozoic beds. The Archean series together, according to Rands, is from 5½ to 6 miles in thickness on the Cape Goldfield. The rocks strike from west-north-west to east-south-east, so that they trend across the so-called "Great Dividing Range," and are discordant with the coast line.

The metamorphic rocks and schists occur in three main areas in Queensland. In the Cloncurry Goldfield and Mackinlay District, in the far west of the State, they outcrop from beneath the Desert Sandstone, and form the eastern end of the Archean rocks of the Central Plateau of Australia. They include in this area some great masses of iron ore of high quality, as at Mount Leviathan, which cannot at present be worked economically owing to their inaccessible position. The second Archean area is in the district round Charters Towers and the Cape Goldfield. It is traversed by the Northern Railway. The schistose rocks here were divided by Daintree into three divisions, which have been reduced by Rands to two. The rocks of the upper division form a long ridge which extends east-south-east from Mount Millar to Mount Remarkable; they consist of quartzites and thin schists. The metamorphic rocks of Charters Towers consist of quartzites, conglomerates, shales, and

slates, and they occur along the western edge of the granite mass of Charters Towers. Their strike is from north-west to south-east.

The third area of the metamorphic rocks is in the Gilbert, Woolgar, and Etheridge Goldfields. The rocks consist of schists intruded by dykes of diorite and quartz-porphyry. The trend of the rocks is generally from west to east, but varies between west-north-west and west-south-west.

A fourth exposure of these schistose rocks is on the western flanks of the Clarke Range, south of Bowen, where the line of granitic rocks of the main range is flanked on the west by quartzites and schists, with an altered, schorl-bearing granite.

A fifth outcrop of schists is on the Peak Downs near Clermont, where the rocks consist of mica and hornblendic schists, striking from north-east to south-west.

Granitic Rocks.—Associated with those foliated rocks are a series of ancient plutonic masses and other igneous rocks. Some of them may be of Archean or of Lower Palæozoic age, such as the rocks which have been described as the "metamorphic granites" of the Pentland Hills, and of the mining fields of Charters Towers and Ravenswood, and the hornblendic granites of Croydon. In other cases the granitic rocks are either certainly of Gympie age, or, as in the case of the granites of the Herberton tin-field, have been regarded as such. The quartz-porphyrites near Townsville are intruded into beds containing *Glossopteris* and cannot be earlier than the Carboniferous. The porphyrites which form the range between the Mary and Maroochy Rivers, cut through Jurassic rocks; and the porphyrites of Moreton and the Darling Downs are younger than the Ipswich series, though they are earlier than the early

Cainozoic basalts. Areas of granites occur in the Kangaroo Hills on the Upper Burdekin, and in the Eidsvold, Mount Perry, and the Normandy Goldfields of the Burnett District.

LOWER PALÆOZOIC.—The Lower Palæozoic rocks appear widely scattered in Queensland, but owing to the rareness of fossils they are still but little known. They were first recorded from Mount Wyatt by M'Coy, who determined some fossils, including *Receptaculites*, submitted to him from that locality, as of Silurian age.

Ordovician rocks in south-western Queensland, belonging to the eastern continuation of the Macdonnell Ranges, have been recorded by Tate; and the recent determination by R. Etheridge, fil., of the occurrence of *Halysites* in the limestones of Chillagoe renders it probable that they are of Silurian age.

UPPER PALÆOZOIC.—The Upper Palæozoic systems, the Devonian, and Carboniferous are well developed in Queensland.

DEVONIAN.—Many of the Queensland schists and slates have been previously assigned to the Devonians,[1] but the evidence for this course is insufficient. The undoubtedly Devonian series begins with the Burdekin limestones, which yield an abundant fauna of Middle Devonian Age. The rocks of this series are mainly limestone very rich in corals. They occur in various areas in the Queensland Highlands. Their most important development is in the Burdekin Valley, where the succession of limestones and shales is said to be 7000 feet in thickness. The Devonian rocks extend from Pentland to Gilberton in a band, 30 miles broad by 60 miles long; the rocks strike from north-east to

[1] A. C. Gregory, "Geological Features of the South-Eastern Districts of the Colony of Queensland," *Parl. Pap. Queensland*, 1879, p. 7.

south-west and generally have a dip to the north-west. They are estimated by Jack to be 20,000 feet in thickness, but his description of the rocks in the lowest—8000 feet, of this series—suggests that they may be of older Palæozoic age. Other outcrops of the Middle Devonian occur in the mountains of the Reid River, crossed by the Northern Railway; also in the neighbourhood of Clermont on the Central Railway, and in the Hunter and Marble Islands in the Northumberland Group, where the Middle Devonian limestones strike from north to south and are faulted against granite.

CARBONIFEROUS.—No Upper Devonian rocks have yet been recognised in Queensland. The Carboniferous system is divided into five distinct series, which, in ascending order, are the Gympie, the Star, the Lower, Middle, and Upper Bowen Series.

The Gympie Beds are the lowest series of the Carboniferous system. They occur north of Brisbane and south of Maryborough. They consist of shales and thin-bedded sandstones, with some impure limestone and coarse conglomerates, and they are traversed by sheets of pyritiferous diorite. The southern part of the Gympie field is thrown eastward by a series of cross-course faults, running east and west. The gold of this series occurs in black shales, the Carboniferous age of which is determined by the occurrence of *Protoretepora ampla*, *Fenestella*, *Productus cora*, etc.

Another outcrop of the Gympie series occurs at Broomfield, where these rocks rest on granite to the west, and are faulted to the east against the Burrum series.

The Gympie series is largely developed in the northern half of Burnett, and extends thence northward to Broad Sound. In the Wide Bay district the Gympie Beds are separated from the coast by some 20 or 30 miles of the

Burrum (Jurassic) formations; but from Port Curtis to Notch Point, south of Cape Palmerston, the Gympie series occupies most of the coast-line. Between Eidsvold and Lochaber, the Gympie Beds consist of sandstone, or quartzites, and slates, which strike east to west. The Cania Goldfield consists of sandstones, slates, and limestone, of which the age is determined by the presence of *Productus semireticulatus.* The Raglan Goldfield consists of slates and sandstones, or quartzites, which are nearly meridional in strike, and dip to the west. The Gympie Beds of the Calliope River include some fine statuary marble.

Near Rockhampton the Gympie series is represented by limestone, with abundant fossils, and extends 10 miles in width with a uniform north-western strike.

The Gympie Beds are identified in northern Queensland in the Hodgkinson and Palmer Goldfields, but some of the beds in this area, such as the Chillagoe limestones, are probably of Silurian age, as they have yielded *Halysites.* The beds assigned to the Gympie series consist of shales and conglomerates. They strike from north-west to south-east, and they are said to be 2000 feet in thickness.

THE STAR SERIES.—This series is regarded as younger than the Gympie, because its beds are so much less folded and disturbed; but no positive proof of its earlier age has been obtained. The beds are best known in the basin of the Great and Little Star Rivers, which are tributaries of the Upper Burdekin. The rocks consist of sandstone and shales with Lepidodendron and some conglomerates. These plant-beds are associated with some unquestionably marine limestones. The most extensive outcrop of the Star Series begins on the Belyando River and extends southward through the Drummond Range,

whose picturesque gorges, 1000 feet deep, expose fine sections of these beds. The rocks are mainly shales and sandstones, which have yielded abundant fossil fish. The rocks are folded into a synclinal trough, of which the axis is crossed by the Central Railway at Bogantungan. To the west of the Drummond Range, the Star Beds dip below the sheets of the basic igneous rocks of Bucklands Tableland.

Another outcrop of the Star Beds occurs at the junction of the Suttor and Burdekin Rivers to the south of the felsite mass, known as Mount M'Connell. The beds here are folded in a synclinal, of which the axis trends north-east to south-west. This basin includes Mount Wyatt at the head of the Sellheim River. Fossils which were determined by M'Coy as Silurian are reported as having come from Mount Wyatt.

Bowen Series.—The Bowen series is divided into three divisions, lower, middle, and upper, which are best developed on the Bowen River Coalfield, which extends from $20\frac{1}{2}°$ S. to 26° S. The northern boundary of the formation crosses the Bowen River above its junction with the Burdekin, and the beds extend southward to the head of the Dawson River. The Bowen Coalfield includes the Leichhardt and the Denham ranges. The Lower Bowen series occurs on the north-eastern border of the field, and its rocks are of two distinct types. The first is a series of altered volcanic rocks, including some agglomerates, which are well shown in the Toussaint Range. These beds are cut out to the south by a fault, which brings the schists on the western flanks of the Clarke range against the rocks of the Middle Bowen series. To the south of the area of schists occurs the second type of the Lower Bowen series, comprising sandstones and shales, some of which are described as

highly altered. Thus, the beds on the Pioneer River west of Mackay are said to show a passage from sandstone into granite. The strike of the beds varies, ranging from north-north-west to north-north-east. Other outcrops of the same type occur west of Mackay and extend along the coast from Repulse Bay southward, past Mackay to Cape Palmerston, where the Lower Bowen Beds reach the shore.

The Middle Bowen series consists of marine and of terrestrial beds containing *Glossopteris*. The marine fossils, such as *Productus cora*, sometimes occur on the same slab with the land plants. The Middle Bowen Beds are chiefly developed on the edge of the Bowen coalfield, the centre of which consists of the uppermost of the three series.

The Upper Bowen Beds are full of *Glossopteris*, and contain many coal-seams. There is one marine band intercalated in the series. They occupy the centre of the great basin of the Bowen Coalfield. Outcrops of the Upper Bowen Beds occurs at Townsville and Cooktown in northern Queensland.

MESOZOIC.—The coal-producing series of rocks in Queensland is continued in the Mesozoic period. An important series of coal-seams occurs in the Lower Mesozoic, while some coal also occurs in the Upper Mesozoic.

The Lower Mesozoic division is divided into the Burrum and the Ipswich series. They are both characterised by the absence of *Glossopteris*, which is succeeded by *Taeniopteris*. These beds have been often regarded as representing both the Triassic and Jurassic systems of Europe, and have therefore been grouped together as the Trias-Jura. But recent consideration of the evidence by Mr. A. C. Seward has led him to regard

Taeniopteris daintreei, one of the characteristic fossils, as of Lower Oolitic age. These beds, therefore, are definitely Jurassic.

The rocks of the Burrum series extend along the east coast from Laguna Bay ($26\frac{1}{2}°$ S.), past Wide Bay, Frazer Island, and Maryborough to Blackwater Creek (24° 25′ S.). They extend inland from the coast for about 30 miles. They are faulted in places against Gympie Beds. One outcrop occurs further north at the southern end of Broad Sound Bay, whence a long narrow coal-field runs along the Styx River into the Gympie Beds.

Along the western edge of the Burrum Beds the rocks are described as tilted and highly altered, where they rest upon granite, which in that case cannot be pre-Jurassic in age.

The Ipswich series occupies 12,000 square miles in the south-eastern corner of Queensland. The main outcrop is traversed by the Southern and Western Railway for 245 miles westward from Brisbane. The rocks consist of conglomerates, grits, sandstones, and shales, and contain seams of coal and fire-clay. These beds are highly tilted around Ipswich, where they are associated with sheets of basalt. At Brisbane they yield important supplies of artesian water. *Taeniopteris daintreei* is a characteristic fossil of these beds. A sheet of interbedded basalt in this series forms the Toowoomba Range, which has a steep escarpment to the east, and a gradual slope westward to the inland plains.

The Ipswich Beds also occur at Stewart's Creek near Rockhampton, where they contain coal-seams, one of which is 26 feet thick.

Cretaceous.—The Cretaceous rocks may be divided into two main divisions. The lower series consists of marine clays, which form the Rolling Downs Formation.

The upper series consists of sandstones, quartzites, and conglomerates, which contain marine fossils in the lower outcrops, as near Maryborough and Croydon, and some plant-remains, including, it is said, *Glossopteris*, which has been recorded by Rands from Betts Creek, on the Cape Goldfield, in a thin bed of shale; and this bed is regarded by Dr. Jack as certainly once continuous with adjacent beds of Desert Sandstone which can be seen to overlie the Rolling Downs Formation. The occurrence of *Glossopteris* in the "Desert Sandstone" would, if confirmed, be an extremely interesting fact. It would show that *Glossopteris* has lasted in sheltered, inland positions in Australia until Cretaceous times. But it seems more probable that some deposits of Palæozoic age are included in the "Desert Sandstone"; for as the specimens have been determined by Mr. R. Etheridge, fil., the identification of the plant cannot be dismissed as a mistake.[1]

The Ipswich Beds pass up conformably into the Rolling Downs Formation; while some of the fossils in the latter are of such Jurassic aspect that the beds were originally identified as Jurassic. The first specimens found were collected on the Marathon River in 1866, and they were determined by M'Coy as Cretaceous. In the following year a fresh collection from the Wollumbilla River was described by C. Moore, who identified the fossils as Upper Oolitic.

More extensive collections were subsequently made by the Haun Expedition on the Walsh River, by Sweet at Hughenden, etc., and they leave no doubt of the Cretaceous age of this great formation. The beds of the Rolling Downs Formation are clays containing nodular limestones, which are full of fossils. The formation is

[1] Mr. E. A. Arber has recently examined the specimens and fully confirmed the identification.

developed in a series of vast, widespread plains with an undulating surface. The clays weather into a soil which is rich in plant-food materials, and is thus very fertile when watered. So that in seasons of adequate rainfall they provide magnificent pasture for cattle and sheep. In times of drought the vegetation is destroyed by the lack of moisture, the soil breaks up into dust, and the country withers into the barren wastes of the "Never-Never Country." The extent of the Rolling Downs Formation is enormous. This series forms the surface or underlies nearly three-quarters of the State of Queensland; it enters the country at the Gulf of Carpentaria, underlies the whole of the Western Plains, and extends southward into New South Wales, and across South Australia to Lake Eyre.

Although it has so far been found impracticable to draw a definite line between the Ipswich and the Rolling Downs series, yet the overlap of the latter from the Ipswich Beds on to the Archean and Palæozoic rocks shows that the Rolling Downs Formation was deposited during the great Cretaceous transgression of the sea.

The exact range of the Rolling Downs Formation in the Cretaceous system is not yet fully defined. Most of its fossils are lower Cretaceous; but others, such as the foraminifera of the Lake Eyre beds, have decided affinities with the Cenomanian. Gypsum is found in great quantities in this series, and is due to chemical alteration of the original deposits of carbonate of lime.

The Rolling Downs Formation is of great economic importance, as it forms the impermeable cap under which are imprisoned the vast stores of water that maintain the flowing wells of western Queensland. The bores which have been sunk through this formation have reached porous sandstones so saturated with water under high

pressure that it rises up the bore hole and overflows at the surface.

The Desert Sandstone once covered nearly three-quarters of the area of Queensland, but it has been worn away by denudation to about one-twentieth of its former extent, and remains only as a series of ridges, peaks, and platèaus, scattered over the plains of the Rolling Downs Formation. The "Desert Sandstone" is composed mostly of sandstones, grits, and conglomerates. The surface has often been converted into quartzite, and is sometimes chalcedonic. Fossils are very scarce and usually difficult of interpretation. In the lower-lying beds near the coast, as at Maryborough and Croydon, it includes marine fossils, such as the casts of Belemnites and the sea-urchin *Micraster sweeti* from Maryborough, and the *Rhynconella croydonensis* from Croydon. Marine fossils, viz. *Leda elongata* and *Avicula alata*, occur 32 miles west of Bundaberg. Norman Taylor obtained specimens of *Ostrea* and *Hinnites* during the Hann Expedition. The only fossils in the Desert Sandstone on the plateau of Central Queensland are obscure plant-remains, silicified trees, and network of lines which may have been formed by sun-cracks on drying mud.

The origin of the Desert Sandstone series has given rise to considerable discussion. According to Tenison Woods, the Desert Sandstone consists of a series of beds of blown sand and subaerial rocks which accumulated in isolated patches on the plains of the Rolling Downs Formation. It is, however, now universally agreed that the scattered outcrops are only fragments left of a once continuous sheet. Most of the material shows that it has been laid down in water; and it may have been accumulated in a series of lakes, and as their accompanying shore deposits. The silicified trees and

the coals found in the Desert Sandstone at Cooktown show that parts of the formation were laid down on land. The formation probably accumulated during the retreat of the sea which had deposited the Rolling Downs Formation.

The existence of marine gulfs into the land, on which the main extent of the formation was laid down, is indicated by the marine fossils found at Croydon, near Bundaberg, and at Maryborough.

No volcanic rocks appear in this formation, but the porcellanous, vitreous character of its surface was regarded by Tate as due to the metamorphic action of an overflowing sheet of lava. This view is unnecessary, as the chalcedonic nature of the surface is no doubt due to the filling up of pores in the sandstone by silica, left on the evaporation of solutions containing it. This surface layer is an efflorescent chert or quartzite.

CAINOZOIC.—The Cainozoic system in Queensland is represented mainly by volcanic rocks, and by broad sheets of lake deposits, river silts, and sheets of blown sand of late Cainozoic age. The eruption of the volcanic rocks, no doubt, began shortly after the beginning of the Cainozoic period; because the Desert Sandstone had been but slightly denuded before the outflow of the Townsville and Hughenden lavas. A great expanse of the older basalts occurs west of the Burdekin, extending northward from Lolworth Creek; and they occupy 2000 square miles of country between the head of the Burdekin and the Einasleigh River and Herberton. Beds of pipe-clay are associated with the basalts, and their fossil leaves enable the age of these basalts to be determined. They are regarded, with considerable plausibility, as corresponding in age to the Lower Cainozoic volcanic rocks of Victoria.

The basalts of the Newer Volcanic series occur north of Cooktown, and in the Einasleigh and the Lynd Rivers. The centres from which the rocks of this period were erupted are still recognisable. A series of hot springs, and some geysers, which have been reported as in action in the Einasleigh valley, appear to indicate the last phase of volcanic activity in that area.

The most interesting of the upper Cainozoic deposits of Queensland are some breccias rich in the bones of extinct marsupials and birds. Most of these beds occur in the valleys of rivers flowing westward from the Queensland Highlands to the Western Plains; but sometimes, as in the Peak district, they occur to the east of the present Divide. The bones occur in great abundance in local patches, where the animals were bogged in the mud of the water-holes, around which they fought during times of drought. The bones occur in gravel, sand, and silt. The chief deposits occur, according to Sir A. C. Gregory, down the western slope of the Queensland Highlands, from near the Divide, down to the level of the Western Plains, as on the banks of the Condamine River. The deposits have been cut through by existing streams, so their antiquity is considerable. The bones are often deeply buried, and there have been great changes in the river systems since their deposition. Thus in places the bones have been found at a depth of 188 feet, as on the Peak Downs; and according to Daintree (1872) these remains occur "in breccias and indurated muds, which are representatives of the beds of old water-courses, through which the present creeks cut their channels." The fossils found in these deposits include various fresh-water mollusca—*Melania pagoda*, *Melania arca*, *Melania subimbricata*, *Limnœa rimosa*, *Physa truncata*, etc. Remains of the crocodile are common in these beds, and

also teeth of Ceratodus. The most important of the bones are those of the giant marsupials, such as *Diprotodon australis, Macropus titan, Thylacoleo, Phascolomys, Nototherium,* etc. According to Mr. Etheridge, no human bones, flint-flakes, or any kind of native weapon have yet been discovered in Queensland in association with these bones. The occurrence of an aboriginal implement at a depth of 60 feet has been reported to me, but the specimen is not yet available for examination. Caves occur in the limestones; and on the floor of these caves there occur fossil bones of marsupials and birds.

4. Economic Geography

The principal industries of Queensland are pastoral, agricultural, and mineral. The pastoral industry occupies the broad, open downs of Western Queensland, which extend from the Gulf of Carpentaria to the borders of South Australia and New South Wales. The land held by pastoralists in 1903 was 337,423 square miles, yielding a rent of £263,900. The soil of much of this country is extremely rich, and it affords magnificent pasturage. The northern districts are best suited for cattle and horses. The higher, drier downs in Southern Queensland are the best for sheep. The western district has a very arid climate with a low average rainfall, and its development is greatly hampered by periodical droughts. Thus the average rainfall of some of the western stations is as low as 6·04 inches on a ten years' record, at Kallidiwarry on the Mulligan River; the mean for three years at Birdsville is 5·72 inches, and the mean of seven years' records at Tenapera is 8·07 inches. The minimum recorded in any one year up to the end of 1898 is 2·47″ in 1892 at Kallidiwarry.

Along the coast the rainfall is heavier:—

The mean at	Brisbane	is	51·32 inches.
,,	Bundaberg	,,	50·70 ,,
,,	Mackay	,,	72·43 ,,
,,	Geraldton [1]	,,	148·80 ,,
,,	Cooktown	,,	71·49 ,,

Most of the western country is underlaid by a subterranean reservoir of water, which can be obtained by bores. Owing to this supply much good country can be used, as stock roads to it can be kept open and some fodder raised by irrigation.

The Darling Downs district is the best pastoral country, having excellent pasturage and a fair water-supply.

Wool is generally the most important export from Queensland, but owing to the widespread destruction of the sheep during the drought of 1901-2, the wool exported fell from over 70,000,000 lbs. in 1899 to 21,000,000 lbs., valued at £1,311,426, in 1902; and 34,979,075 lbs., value £1,883,752, in 1903.

The exports of preserved and frozen meats in 1902 were worth £1,557,266, and in 1903 was worth £971,099. The number of sheep had fallen from 15,226,479 in 1899, and 19,500,000 in 1896, to 7,213,985 in 1902, and 8,392,044 in 1903. The number of cattle fell from 6,500,000 in 1896 to 5,500,000 in 1902, and to 2,481,717 in 1903. The number of horses in 1899 was 479,000, which fell to 399,000 in 1902. The export trade in horses is mainly with India. Large mobs of cattle are driven overland from the back plains of Queensland to the South Australian Railway at Hergott.

[1] The wettest station; the mean for thirteen years' record up to 1898. The maximum record, in 1894, is 211·24 inches.

The agricultural industry is mainly in the coast-lands in the southern part of the State. The farms are mostly small, for the crops raised require close attention. Sugar-cane, bananas, and tropical fruits are grown along the coast. The largest acreage (133,099 acres in 1903) is generally under maize, and sugar-cane is second according to acreage, covering 111,516 acres. Wheat is usually the third, but the severe drought of 1901-2 led to the reduction in the acreage of wheat from 87,232 acres in 1901, to only 1880 acres in 1902; but with the return of a good season it rose to 138,096 acres in 1903, taking first rank among the agricultural products of the State. The wheat is grown on the highlands in Southern Queensland. The yield ranged from 9½ bushels to the acre in 1895 to 19·4 bushels in 1901, and 17·65 bushels in 1903. But it fell in 1902 to 3·2 bushels, owing to the drought. Sweet potatoes are grown, and largely used for feeding stock. Much land is suitable for rice, tobacco, cotton, coffee, and arrow-root. Bananas are mainly grown in the north around Cairns, and in the south around Brisbane. Cocoa-nuts, oranges, lemons, etc., will grow along the coast, especially in the north. Dairy-farming is developing. The sugar industry is mainly in the north around Mackay and Cairns. There is a bonus of 4s. per ton on sugar-cane raised by white labour. The field work was originally all done by Kanakas, or indentured South Sea Islanders; but an Act of 1901 prevented the entrance of any fresh Kanakas, and the last of them will have served their time and are to be returned to their islands at the end of 1906. The industry is accordingly changing from large sugar estates, each with its own mill, into many small farms, whose canes are crushed by independent mills. The total sugar crop in 1903 was

91,828 tons, an average of 1·52 tons per acre; in 1903 there were 42 mills at work. The acreage under sugar in 1904, 120,317 acres, is the maximum record.

The mineral industry of Queensland is of great importance; gold being the largest export of the State. The chief gold-mines are those of Charters Towers and Mount Morgan, the latter of which, after being one of the richest and most famous gold-mines in the world, is now changing into a low-grade copper-mine. In southern Queensland the chief gold-mine is at Gympie. The total number of miners employed in 1903 was 11,325 and 612 Chinese. The total yield of gold for 1903 was 921,363 oz., worth £2,839,813. Most of it came from Charters Towers, Gympie, and Mount Morgan. The quantities of tin raised in 1903 was 3709 tons, valued at £243,149. Copper is found in the Herberton district, at Chillagoe, and at Clermont. The Chillagoe field is the most promising, but the yield is still small. The mineral output for 1903 included:—

Gold	921,663 oz.	Value	£2,839,813
Copper	4,916 tons	,,	285,122
Tin	3,709 ,,	,,	243,149
Coal	507,801 ,,	,,	164,798
Silver	642,125 oz.	,,	65,538
Lead	3,795 tons	,,	43,639

Tin is widely distributed; the chief mines being worked at Herberton, Cooktown, and the Stannary Hills, which has now the largest yield of any tin-mine except Mount Bischoff and Dolcoath. Coal occurs in southern Queensland near Ipswich, Broad Sound Bay, etc. But owing to the easy development of the coalfields in New South Wales, the Queensland coal-mines are still little worked.

The manufactories are situated in the coast towns,

and principally make articles of which local production is necessary, such as bricks, pottery, furniture, clothing, etc.; or they work up the chief natural products, such as sugar, meat, and timber. The total number of factories during 1903 was 2001, employing 19,286 hands.

The fishing industry is of some importance, and is engaged in hunting the Dugong for its oil, beche-de-mer, a Holothurian exported to China, and pearl-fishing; in 1902 there were 276 licensed pearl-boats, employing 2624 men, who procured 961 tons of pearl shell, worth £129,267.

The population of Queensland, according to the census of 1901, was 503,266, including 9313 Chinese, 9327 Kanakas, and 6670 aborigines.

5. Political Geography

The Governor is appointed by the Crown. The Legislative Council consists of forty-two members nominated for life by the Crown. The Chamber which in England is called the "Lower House"—a term emphatically rejected in Australia—is the Legislative Assembly of seventy-two members, who are elected triennially. Members of the Legislative Assembly receive an allowance of £300 a year, and also travelling expenses.

The revenue for the year ending June 30, 1904, was £3,595,440, and expenditure for the same year was £3,607,864. The State debt is £41,273,297.

Education is free, but owing to the scattered and limited population of the country it has made less progress than in the other States. It has not yet been made compulsory; but power has been given to the

Governor in Council to make it so whenever it is considered advisable. The State has no university.

All male residents in Queensland between the age of eighteen and sixty may be called upon to go through three years' training in the defence force.

The railway system is extensive, there being 3044 miles open for traffic on June 30, 1904. The lines are all on the narrow gauge of 3′ 6″. They cost nearly £21,000,000; the gross earnings in 1903-4 were £1,305,552, and the working expenses were £811,951. The railways are hampered by being disconnected, most of them starting from coast ports and running westward over the Highlands to the Western Plains. Proceeding from north to south, the first railway goes from Cooktown to Palmerville; the second from Cairns to the Chillagoe Mining-Field; a third, the Northern Railway of Queensland, runs south-westward from Townsville, crosses the Burdekin River, and goes through Charters Towers, the Cape Goldfield, and Hughenden, to Winton in the Western Plains; a small branch line from it goes to the mining-field of Ravenswood. The Central Railway starts from Rockhampton and goes almost due westward past Emerald to the head-waters of Cooper's Creek at Barcaldine, and Longreach on the Thomson River. This railway is mainly through agricultural and pastoral country, but a branch line to Clermont serves the copper-mines of the Peak district. The Southern and Western Railway starts from Brisbane and goes westward for 483 miles to Charleville, on the Warrego River, and then runs southward along the plains beside that river to Cunnamulla, 604 miles from Brisbane. A branch line to the south connects this railway and the railway system of New South Wales and Sydney. Another line goes

northward from Brisbane to Gympie, Maryborough and Gladstone, and connects the Southern with the Central Railway at Rockhampton.

The land system of Queensland is administered by a Land Court. Vast tracts of land are let under lease for sheep and cattle runs. As the leases lapse some of the land is thrown open for "selection." A selector can apply for a tract of land, not exceeding 1280 acres in extent, at a rental of $\frac{1}{40}$th part of the price agreed upon. If the selector fulfils the conditions as to residence and improvements, after five or ten years respectively for agricultural or pastoral land, he can apply for the freehold at the price previously arranged; the rent he has paid during the meantime being deducted therefrom. Land is also sold outright by the Lands Department by auction at an upset price of 13s. 4d. per acre; it is then sold unconditionally, and the price may be paid as rent at 5 per cent of the purchase price. Grazing selections, with a maximum of 60,000 acres, are let at not less than ½d. per acre, the rent being reassessed at intervals of seven years. Land suitable for dairy farms may be let in areas of not more than 20,000 acres, on residence conditions, at a rent of ½d. per acre.

Co-operative agricultural colonies are established on easy conditions. The co-operative communities consist of not less than thirty persons, and the maximum allotted to each is 160 acres. The land may be taken at a rent of 5 per cent on the valuation accepted by the lessee and the Land Court, and can be acquired as a freehold by payment of the balance.

6. Towns in Queensland.

BRISBANE (27° 28′ S. lat., 153° 6′ E. long., 58 feet above sea-level), the capital of Queensland, is situated on both banks of the Brisbane River, 25 miles by river from Moreton Bay. The river is crossed by a bridge 1080 feet long, with swing openings. The city was founded in 1824 by Sir T. Brisbane. It first made important progress after 1842. Its public buildings include the House of Legislature, the Governor's Residence, the School of Arts, and the Grammar School. The climate is dry and healthy, though the temperature is high in the summer. The mean annual temperature is 68°. The population is 28,953; with that of the suburbs and within a radius of ten miles it is 119,428.

BUNDABERG (24° 53′ S. lat., 152° 21′ E. long.), a port in the county of Cook, on the banks of the river Burnett, about 8 miles from its mouth in Wide Bay. It is 217 miles north of Brisbane, with which it is connected by rail. The staple exports are sugar, golden syrup, and sawn timber. The Woongara scrub, which is on soil of volcanic origin, is situated in the district. Coal has been found, but the seams are thin. The population of the town is 5200; within five-miles radius, 9666.

CABOOLTURE (27° 6′ S. lat., 152° 59′ E. long.), in the county of Canning, 32 miles north of Brisbane, is on the north bank of the Caboolture River, opposite Morayfield on the southern bank. Steamers come to the town for timber. Dairy produce, maize, and potatoes are the other chief exports. The population of the town in 1891 was 248, and of the district 18,591.

CAIRNS (16° 55′ S. lat., 145° 47′ E. long.), in the county of Nares, is a seaport 990 miles north-west of Brisbane, at the mouth of Trinity inlet, on the western

shores of Trinity Bay. It has a commodious and well-sheltered harbour. The main products of the district are sugar, bananas, pine-apples, maize, and timber. Tin is found at the Tate River. The population in 1901, within five-miles radius, was 3557; and within the district, 11,013.

CHARTERS TOWERS (20° 3′ S. lat., 146° 18′ E. long., 1000 feet above sea-level), a mining town in the Kennedy district and county of Davenport, is 82 miles by railway from Townsville, and about 820 miles north-west from Brisbane. The Burdekin River is eight miles distant. The town is situated on the northern spurs of the Towers Mountain, and is the centre of the largest goldfield in Queensland. Population within five-miles radius, 20,976.

CHILLAGOE, a copper and silver mining locality in county Chelmsford, between the Tate and Walsh Rivers, and about 80 miles north-west from Herberton. Population of the district about 5000.

GYMPIE (26° 12′ S. lat., 152° 38′ E. long.), a goldfields township, in the county of March and the district of Wide Bay. It is on the side of a range of hills on the upper part of the river Mary, 107 miles north from Brisbane, 54 miles south from Maryborough. Gold was first discovered in 1867 by James Nash. The adjacent country is agricultural and pastoral. Population of town, 11,959; within five-miles radius, 14,431.

IPSWICH (27° 37′ S. lat., 152° 48′ E. long., 65 feet above sea-level), at the head of navigation on the river Bremer, 23 miles west of Brisbane, is the capital of the district of West Moreton. The chief part of the town is on the south side of the river, and is connected by two bridges to the north side. It is a manufacturing town, with adjacent coalfields, and the district produces rich crops of oats, maize, potatoes, and lucerne. Population of

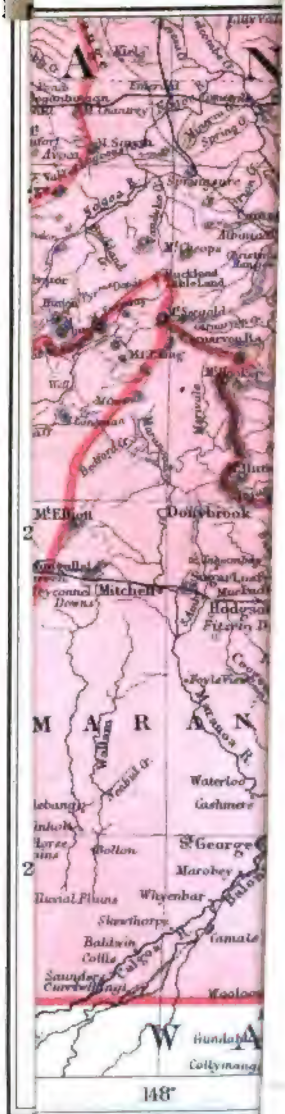
town, 9937; within five-miles radius, including suburbs, 15,246.

MACKAY (21° 9′ S. lat., 149° 13′ E. long.), a seaport on the south bank of the Pioneer River, 625 miles north-west of Brisbane, in the district of Kennedy and the county of Carlisle. The district is pastoral and agricultural, and it is the centre of the largest sugar-producing district in Queensland. Coffee, cocoa-nuts, bananas, etc., are grown. Gold and coal occur in the neighbourhood. Population of the town, 4091; within a five-miles radius, 5157.

MARYBOROUGH (25° 33′ S. lat., 152° 43′ E. long.), in Wide Bay and the county of March, is on the north bank of the Mary River, 25 miles from its mouth, and 180 miles north of Brisbane. It is the centre of a rich agricultural district, producing maize, potatoes, lucerne, bananas, sugar, and oranges. Population of town, 10,159; within radius of five miles, 12,900.

MOUNT MORGAN, a gold-mining town in the district of Port Curtis, and county of Raglan, is near the head of Dee River, 24 miles S.S.W. of Rockhampton. It is the site of perhaps the most famous single gold-mine in the world, which is now, however, turning into a copper-mine. Population within five-miles radius, 8486.

ROCKHAMPTON (23° 24′ S. lat., 150° 30′ E. long.), in the district of Port Curtis, is the commercial capital of the Central Division of Queensland. It stands on both banks of the Fitzroy River, 43 miles from Sea Hill, the mouth of the river. It is 335 miles north-west of Brisbane, and is the starting-place of the Central Railway, which goes inland for 427 miles to Longreach. It is surrounded by rich agricultural land, and has large meat-preserving works. It was founded during the Canoona rush in 1858. Population within five-miles radius, 19,691.



Emerald
Springsure
Mt Cheops
Mitchell
Hodgson
Sugar Loaf
Waterloo
Cashmere
St George
Bollon
Marober
Whyenbar
Baldwin
Collis
Saunders
Burial Plains
Maranoa R.
148°

e, W.C.

Roma (26° 36′ S. lat., 148° 42′ E. long., 978 feet above sea-level), in the district of Maranoa, on Bungil Creek, 318 miles W.N.W. of Brisbane, is the chief market-town for the pastoral stations on the Fitzroy Downs. The soil serves for agriculture, but the results are rendered precarious by droughts. The town is lighted by natural gas from a flowing well. Population of town, 2371; of district, 7110.

Toowoomba (27° 34′ S. lat., 151° 58′ E. long., 1921 feet above sea-level) is the chief inland town in Queensland; it is on the summit of the divide on the Darling Downs; it is at the head of Gowrie Creek, a tributary of the Condamine, 101 miles west of Brisbane. Population of the town, 14,600; of the adjacent district, 37,000.

Townsville (19° 10′ 10″ S. lat., 146° 57′ 56″ E. long.) is the principal city in North Queensland, and is in the district of Kennedy and the county of Elphinstone. It is on the shore of Cleveland Bay, a subdivision of Halifax Bay, 870 miles north-westward of Brisbane. It is the port of the Burdekin basin and the Richmond Downs. The Northern Railway starts inland from it to Hughenden and Winton. The adjacent district produces much sugar. The population of the city and suburbs is 12,717; of the district, 15,000.

Warwick (28° 12′ S. lat., 152° 4′ E. long., 1497 feet above sea-level) is in the county of Merivale, and on the Darling Down, 100 miles south-west of Brisbane. It is on the River Condamine, 64 miles from the New South Wales border, and is in the centre of one of the richest agricultural districts in Queensland, producing wheat, maize, lucerne, fruits, as well as cattle and wine. Population of town, 3836; of the district, 15,000.

QUEENSLAND.

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The chief data for the deep wells and water-supply are in the Annual Reports of the Hydraulic Engineer, Mr. J. B. Henderson.

For the early history, see reference on p. 82.

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CHAPTER XIII

VICTORIA

VICTORIA occupies part of the south-eastern corner of Australia. It is bounded to the north and north-east by New South Wales, to the west by South Australia, and to the south by the Southern Ocean. It tapers eastward to a point at Cape Howe. It lies between the 34th and 39th parallels of south latitude and the meridians of 150° E. and 141° E.

It is the smallest State on the mainland of Australia, Its length is 420 miles; its breadth, 250 miles. Its area is 87,884 square miles, or 56,245,760 acres. Its coast-line is about 600 miles long.

The islands to the south, in Bass Strait, are all said to belong politically to Tasmania.

Victoria was first seen by white men, so far as known records go, on April 19, 1770. Cook then saw the coast from Point Hicks Hill to Cape Howe. The eastern coast was explored by Bass, who first proved the existence of the Strait named after him; the rest of the coast was discovered by Grant (1800), and Murray (1802), one of whose seamen, named Bowen, discovered Port Phillip, and Flinders (1802). The first settlement was attempted in 1803, when Collins landed a convict expedition on the sandhills near Sorrento, inside Port

Phillip. He soon withdrew the expedition to Tasmania, convinced that Port Phillip "cannot, nor ever will be resorted to by speculative men." Tuckey, his lieutenant, predicted that the country would be for ever left to the kangaroos, for whom alone, in his opinion, it was fit.

Whalers and sealers used various points along the

Photo. *A. E. Kitson.*

PORTLAND, FROM THE NORTH—THE FIRST PERMANENT SETTLEMENT IN VICTORIA.

coast as the base of their operations, and the Hentys' station at Portland was the first permanent settlement in Victoria. It was founded on November 19, 1834. An earlier colony had been landed on Western Port, in 1826, in order to keep off the French; but it was withdrawn in 1828, after the fear of the French occupation of the coast had abated.

The first inland explorations were those of Hume and

Hovell (1824-25), who crossed from Sydney overland to Geelong, and of Sir Thomas Mitchell (1836), who called the country Australia Felix. His enthusiastic descriptions of Victoria aided the settlement of the country, which had been planned in 1835 by the Port Phillip Association of Tasmania. Batman and Fawkner, in 1835, occupied and founded Melbourne. Difficulties with the authorities hampered the settlement for eighteen months, and the first land sale was not held until June 1, 1837,[1] after which progress was rapid. Men came overland from Sydney and settled in the northern districts and Gippsland; while emigrants from Tasmania and England occupied the southern and western parts of the State. Nearly all the country suitable at that period for pastoral settlement was occupied between 1837 and 1846.

The country was known as the Port Phillip district, and was a part of New South Wales till its separation as the Colony of Victoria in 1851.

1. The Physical Geography of Victoria

Victoria consists geographically of four main divisions:

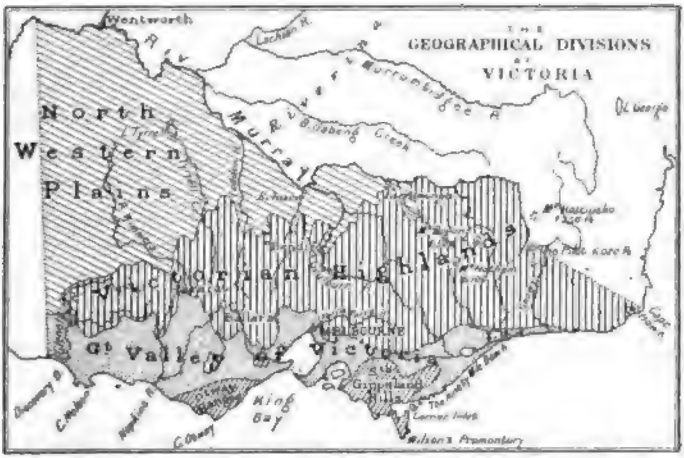
1. The Victorian Highlands.
2. The Great Valley of Victoria.
3. The Otway Ranges, and South Gippsland Hills.
4. The North-Western Plains.

The original mountain system of Victoria consisted of a series of ranges striking northward and southward. This system existed at a very early date (the Lower Palæozoic), and its ranges are now represented only by the worn stumps of the old mountains.

This mountain system was replaced by a mountain

[1] The lots realised an average of £35 per half acre.

chain which in Upper Palæozoic times extended east and west across Victoria. This second series of mountains was in its turn cut down by river action to a low-lying plane (a peneplane), which was subsequently uplifted as a plateau, the dissection of which, in comparatively recent times, has produced the existing mountainous Highlands of Victoria. The uplift of the mountainous country was accompanied by the subsidence



of two areas: one of them forms the Great Valley of Victoria, trending across the southern part of the State, from east to west; the other and still vaster subsidence formed the basin now occupied by the North-Western Plains.

The Victorian Highlands are a belt of highland country which trends across the State from the county of Dundas, in the far west, to the border of New South Wales, in the east. They begin in the west as a narrow band, which increases in width as it is followed east-

ward; at length it stretches from the Murray in Benambra to the southern coast in Croajingolong, and thus occupies the full width of the State. The main axis of these Highlands consists of a series of massifs of granite and grano-diorite, forming the Primitive Mountain Axis of Victoria. These massifs, and the folded sedimentary rocks upon their flanks, have been cut down into a series of peneplanes, which extend as spurs, northward and southward, from the central line of the Victorian Highlands. The Highlands begin in the west as the county of Dundas, where the old rocks have been planed down, and are in the main covered by thick deposits of Cainozoic age. The old rocks are exposed on the floors and sides of the valleys, the surface of the Dundas tablelands being composed of younger sediments. To the east of Dundas are the parallel mountains known as the Victoria Range, the Sierra Range, and the Grampians. After passing these mountains, the Highlands stretch out to the north in the mountainous country to which Sir Thomas Mitchell gave the name of the Pyrenees. It is composed of a dissected peneplane, which slopes downward to the north and disappears beneath the silts of the North-Western Plains. The rainfall in the Pyrenees is comparatively slight, averaging from 17 to 19 inches per annum; the ground slopes downward to the north and is fully exposed to the summer heat, and the soil formed from its rocks is poor and sandy. Hence the larger part of the Pyrenees is useful only as a pastoral region, and is covered with thin gum forests. The floors of the valleys have richer soil and are occupied by settlements, from which are managed the cattle-runs on the mountains. The country includes many famous mining centres, such as Moliagul, which has yielded the Welcome Stranger

Nugget, the greatest gold nugget yet found in the world.

The area of the Pyrenees is bounded to the east by the broad valley of the Loddon, to the east of which is the Bendigo Peneplane, another northward spur from the Highlands. Its soil is similar to that of the Pyrenees, but the country as a whole is more level; the valley floors are wider, and thus agriculture is possible to a greater extent. This district owes its greater prosperity, however, to the great mining centre of Bendigo, while only a little across its southern border are the mining centres of Castlemaine and Maldon. Still further eastward is the long ridge known as the Colbinabbin Range, which runs 50 miles northward from Heathcote; and eastward again is the Rushworth Peneplane, which is comparatively small and less dissected. It is bounded to the east by the basin of the Goulburn, which makes a deep notch, southward, into the Highlands. The western banks of the Goulburn Basin are formed by the Moira Peneplane, which is intensely dissected, and extends northward from the Strathbogie Range nearly to the Murray. The comparatively narrow basin of the Ovens separates the Moira Peneplane from that of Northern Benambra, which has a comparatively short slope from the axial line of the Victorian Highlands northward to the Murray. The northern part of Benambra consists of very irregular country, useful only for pastoral work; though there are wide wheat-fields and vineyards on the flood-plains of the Murray and its tributaries. The chief mining of the district is for tin, at Cudgewa and Koetong, and for gold from the refractory ores of Bethanga.

The Victorian Highlands also send off a series of spurs to the south, of which the most important is the

peneplane or plateau of Ballarat, historically the most famous of the Australian mining centres. This plateau forms all the high country from Skipton on the west to Bacchus Marsh, where it ends in a steep scarp overlooking the Melbourne basin. The Ballarat Plateau extends to the south in two projections at Rokewood and Steiglitz. Eastward from Melbourne a spur from the Highlands forms the Yarra Plateau, and on its surface is the vast pile of igneous rocks which form the well-known Dandenong Ranges. Beyond the basin of the Upper Yarra comes a high, extensive peneplane, of which the best-known summit is Mount Baw Baw; nearly the whole of this district is still covered with dense gum forest, traversed by tracks and roads to the mining camps. The next spur is the Dargo Peneplane, which rises still higher, and forms the Snowy Plains. They are covered the whole winter by a thick sheet of snow, which stops all traffic across them, except the monthly mail-man, who traverses the plateau on ski. Farther east, in Croajingolong, the Highlands reach the shore of the Southern Ocean.

The highest part of the Victorian Highlands occurs in North-eastern Victoria, between the peneplane of Benambra and that of Baw Baw and Dargo; and here it rises into the two highest Victorian Mountains. They are Mount Bogong (6508 feet), a flat-topped plateau which is used in summer for grazing stock; and Mount Feathertop, a sharp peak on the ridge which separates the Kiewa from the Ovens, to the east of the mining town of Harrietville.

The peneplanes projecting from the central band of the Highlands are separated from one another by a series of basin-shaped depressions and valleys, opening northward on to the North-Western Plains, and southward

into the Great Valley of Victoria. On the northern side of the Highlands there are (1) the broad basin of the Wimmera, to the west of the Pyrenees; (2) the basin of the Loddon, to the east of the Bendigo Peneplane; (3) the basin of the Goulburn, between the Rushworth Peneplane and that of Moira; (4) the Ovens basin, between the Moira and Benambra Peneplanes.

To the south of the Highlands the main basins, from

Photo. *A. E. Kitson.*

A TYPICAL BUSH INN, IN THE EASTERN HIGHLANDS OF VICTORIA.

west to east, are the basins of the Glenelg, of Hamilton, of Hampden, of Melbourne, of the Upper Yarra, and of the Gippsland Lakes. These basins together form the Great Valley of Victoria, which consists of a long belt of low-lying country floored with Cainozoic rocks, and extends from the South Australian frontier to the coast of Croajingolong. It includes the coastal plains up the basin of the Glenelg; the great basalt plains of Villiers and Hampden, on which are the lakes Korangamite,

Colac, and Kolungulac, and the chief extinct volcanoes of Victoria, Mount Elephant, Mount Leura, Tower Hill, Mount Noorat, etc.

The wide western plains of Victoria, owing to the moderate rainfall, the fertile volcanic soil, the rich turf, and the scarcity of trees except along the river-courses, are occupied by the great sheep stations of western Victoria. The country was occupied by Victorian squatters, who, taking up wide tracts of these western plains, made great fortunes from the rapid increase of their prolific flocks and the high quality of the wool. This country was especially suited for use as sheep stations, owing to the large tract of country which could be thus used with a small amount of labour. But now, with a larger population and better labour-supply, the land can be made to yield richer returns by farming. The Western Plains are being cut up into dairy-farms, in most of which the farmers, instead of paying their rent in cash, pay in milk.

The Great Valley of Victoria sweeps round the southern foot of the Ballarat Plateau and enters the Melbourne basin. Port Phillip forms the lowest depression of the Great Valley. Still farther eastward, the valley is continued between the Yarra Plateau, the Dandenong Ranges on the north, and the old peneplane of the Mornington Peninsula. The valley widens out again into the Upper Yarra basin, which was doubtless once continued southward into the plains around Western Port. Then the valley closes in between the Baw Baw Peneplane and the South Gippsland Hills. It crosses the Drouin Gap, and widens out again along the valley of the Latrobe, and then expands into the broad plains around the Gippsland Lakes. The south-eastern boundary is the Ninety Mile Beach, which curves north-eastward and meets the southern edge of the Victorian Highlands near Red Bluff,

east of Lakes' Entrance. The eastern part of the Great Valley contains much low-lying land, which was originally swamp; and this part of the country grew prosperous much more slowly than the Western Plains, for it required more labour to make it productive. When, however, the swamps are drained, the soil, as in Kowerup Swamp, is of high agricultural value.

The eastern end of the Victorian Valley is traversed by the railway from Melbourne to Bairnsdale. The chief towns along it, such as Sale, Stratford, and Warragul, are the markets for the agricultural settlements along the valley and its tributaries; and also for the pastoral stations on the Gippsland Hills; and for the mining centres among the mountains, such as Walhalla, with its famous gold-mines, and the coalfields of South Gippsland.

The Great Valley of Victoria was no doubt at one time bounded to the south by a continuous mountain chain, but this has now been broken up into a series of disconnected ranges. To the west are the Otway Ranges, formed of Jurassic mudstones, containing occasional thin seams of coal. Owing to its high rainfall and fertile soil the country is covered by dense, almost impenetrable forest. It is part of an old plateau, deeply dissected by narrow, forest-clad gorges, and progress is only reasonably practicable by following the crests of the spurs and ridges. Branches from the South-Western Railway of Victoria have been constructed into the ranges for the sake of the timber, and tracks have been cut through the forests to holiday resorts, such as Lorne and Apollo Bay, along the southern coast.

To the west of the Otway Ranges, around Portland and Warrnambool, the basalt plains of the Great Valley reach the coast, and the southern part of the valley is a well-developed coastal plain. The same coastal plain

reappears at the eastern end of the Otway Ranges, forming the level country between Geelong and the southern coast. It also includes the Bellarine Hills on the southern side of Port Phillip. The coastal plains are interrupted by a fragment of the Otway Ranges, known as the Barrabool Hills; and the Jurassic rocks occur again under the Bellarine Peninsula. On the eastern side of Port Phillip they are brought up by a powerful fault, and the older rocks—granites and Ordovician sediments—form the Highlands of Mornington, of which the highest summit is known as Arthur's Seat. To the east of these hills is Western Port, where the Great Valley is again widely open to the coast. Phillip Island, between the two mouths of Western Port, contains, in the peninsula of Cape Woolamai, a fragment of the old southern bank of the Great Valley.

To the east of Western Port are the South Gippsland Hills, which are composed of the same rocks as the Otway Ranges. They here contain a much richer series of coal-seams, including the coalfield of Korumburra, Jumbunna, and Outtrim. The South Gippsland country is an intensely dissected peneplane; it was covered by dense forest, which is now being rapidly cleared to give space for dairy-farms. A great triangular depression has broken into the South Gippsland Hills, to the north of Anderson's Inlet, by the subsidence of a block of country between two lines of faults. The sunken country is covered by sheets of sand, and the soil is comparatively barren; hence the country is left as moors for sheep, while cultivation is limited to the strips of alluvium beside the creeks. The various ridges in the South Gippsland Hills have local names. The most important is the Bass Range, which runs north-eastward from San Remo, at the entrance of Western Port; its continuation is the

Photo. *A. E. Kitson.*

IN THE SOUTH GIPPSLAND HILLS AT KONGWAK.

The clearing, with the few dead gum trees, is a farm on Jurassic mudstones. The forest-clad hill on the right is due to an outcrop of barren Silurian rocks.

Strzelecki[1] Range, about Korumburra, and the Hoddle Range, which runs north-eastward from Waratah Bay into the hills of Jurassic mudstones of south-eastern Gippsland.

To the south of the Gippsland Hills, and separated from them by the sunken area which includes Corner Inlet and Waratah Bay, are two remnants of an old mountain chain, the Bunurong Range. They are the promontory of Waratah Bay, with its limestone quarries, and the granitic mountains of Wilson's Promontory. The rugged scenery of the granitic hills of Wilson's Promontory, the pretty coves along its coast, and its isolated position, have led to the proposal that it should be reserved as the National Park of Victoria.

The Bunurong Range was at one time continuous across Bass Strait from Western Port to Tasmania.

The North-Western Plains occupy the whole of the north-western corner of Victoria. These plains are young plains, and their surface in many parts of the country is unbroken. Occasional hills, such as Pyramid Hill and the Terricks, rise above the plain, and from their summits there is a wide outlook over monotonous level plains, across which the roads run in perfectly straight lines, and the paddock fences are arranged with the regularity of a chess-board. The country is treeless, except for a few lines of gums dotted along the creeks. To the north the plains extend as far as the eye can follow them; but to the south the Bendigo Peneplane, or its outliers, the granite peaks of Mount Korong, may be dimly discerned in the far distance. The plains are of two distinct types: the open flats, to which the term plain is locally restricted, which are used as sheep-runs and wheat-fields. They

[1] Pronounced Streleski.

range from Victoria across the Murray into the Riverina (p. 297).

The second type of country in north-western Victoria is the Mallee, which is composed of older plains, now worn into a gently undulating surface. The ground is mostly covered by a thin, sandy soil, below which, at a depth of a few inches or a foot, is a layer of rock, usually limestone, ironstone, or chert: this rock is an efflorescent formation, due to the deposition of materials raised to the surface by capillary action, and there deposited by the evaporation of the water during the long heat and drought of the summer. At intervals there are broad tracts of the dry, barren beds of former lakes, and, elsewhere, lines of sandhills. An excellent description of the Mallee country is given by Stuart Murray:[1]—

"The area known as the Mallee country comprises about 11,000,000 acres within Victoria, and occupies the north-west part of the Colony. It may be roughly described as bounded on the west by the South Australian boundary line, north by the Murray River, east by the Little Murray, or Murabitt, and the Loddon River, and south by an irregular line leaving the Loddon near Lake Leaghur, crossing the Avoca at the offtake of Mosquito Creek, and passing by the north end of Lake Buloke, by Warracknabeal and Dimboola, to the South Australian boundary in latitude about 36° 40′.

"It is not by any means all covered, or has ever been covered, with the dwarf eucalypt known as Mallee. Probably not more than half of the entire area is covered with this kind of vegetation; the remainder consists of forests of box, buloke, and native pine, thickets of dwarf

[1] Stuart Murray, "Water-Supply to the Mallee." Report to Hon. Minister of Water-Supply. Melbourne, 1892.

trees, and shrubs of many varieties, heath country—so called—that is, sandy wastes, with a thin covering of stunted pine scrub, interspersed with epacris and other heath-like plants, and considerable stretches of open plains, generally well grassed. Composed of ancient estuary beds, it is level in the same sense as the riverine country bordering the Goulburn, the Loddon, or the Wimmera; but presents to the eye expanses of level land, intermixed with rolling downs, and with mounds and ridges of blown sand. These latter frequently attain an altitude of 50 or 60 feet, occasionally 80 or 100, and in a few instances nearly 200 feet. Wherever the country is sufficiently open to permit a view of the distance, these sandhills are conspicuous objects on the horizon; in fact, they are among the most striking of the physical features of this region. The soil is of very variable quality, whether considered from an agricultural or a pastoral point of view. Probably two-thirds of it is in some degree fit for the plough; the remaining third is only fit for the grazing of stock, and is never likely to be subjected to any description of tillage. Of the agricultural portion, the soil consists of loam, varying from sandy to clayey, the lighter kinds predominating. The sub-soil is of more retentive material, generally clay with an infiltration of lime, and frequently with beds of nodular limestone." [1]

The South-Western Plains of Victoria consist of many confluent sheets of basalt, formed by flows of lava that have spread out radially from numerous scattered volcanic vents. The hollows between the basalt sheets became water-logged and filled with swamp, while the rivers dammed up by the lava-flows formed lakes. As many of these lakes had no outlet, they became salt, owing

[1] These limestones are efflorescent in origin.

to the concentration of the alkalies leached from the lavas; and the subsequent evaporation or drainage of the lakes has left plains of salt-charged mud. Elsewhere the depressions have been filled by sheets of alluvial soil, while the weathering of the basalt has formed a soil rich in plant-foods. In places these soluble constituents have been washed from the soil, and the decomposed basalt forms a kind of laterite, consisting of ironstone concretions, crowded together like the pebbles in a bed of gravel. In such cases the soil is poor, and only suitable for sheep-farming, whereas the chocolate soil formed from the basalts, or the light loam formed from the volcanic tuffs, are available for dairy-farms and agriculture. Some of the volcanic soils are so fertile that the land sells for £80 per acre, and even then yields excellent profit to the farmers, from its abundant crops of potatoes and onions.

Some of the lava-flows have broken up into vast piles of basalt boulders, which form the country known as the Stony Rises. The boulders are heaped up, with only small patches of soil in the hollows between. This country is of little value; the rabbits have occupied it, and eaten all the vegetation except the gum trees and the bracken ferns, which have a monopoly of the undergrowth.

The South-Western Plains cover about 10,000 square miles, and range from sea-level to a height of about 800 feet. In many places the country, in a general view, appears quite level, but it has been dissected by river gorges two or three hundred feet in depth, which give instructive sections of the volcanic rocks.

2. The Mountain System

The mountain system of Victoria may be divided into three groups. The oldest system is represented by mountain lines running from north to south, of which only a few remains are left. Of these the two main fragments are the Colbinabbin Range and its southward continuation, the Mount William Range, which doubtless once ran southward across the Melbourne basin and passed a little to the west of Geelong. The second member of this group is Mount Stavelly, and other hills made of rocks of the same age, that occur near the eastern foot of the Grampians.

There is another still younger series of north and south ranges. The most conspicuous are the Grampian Group—the Sierra Range, the Victoria Range, and the Black Range. They occur in Western Victoria, and consist of a parallel series of folded mountains composed, in the main, of sandstones of Upper Palæozoic age. Their highest peak is Mount William, the finest view-point in Western Victoria. A fragment of a mountain range of the same age and similar structure forms the Cathedral Mountains in the Acheron Valley, to the north-north-east of Melbourne. It is now overshadowed by the great volcanic pile, Mount Torbreck, which rests against it on the east. The Snowy River Mountains are another old north and south range, and are composed of a series of Lower Devonian volcanoes, which have now been dissected, so that their plutonic stumps are exposed on the surface. The last of the important ranges, running from north to south, includes Mount Howitt and Mount Wellington; it consists of a plateau of folded Devonian sandstones.

These meridional mountains are less conspicuous

than the Victorian Highlands, of which the axis consists of nine or twelve granitic massifs, which together form the Primitive Mountain Chain of Victoria. These have been classified as follows:[1]—

(1) The Dundas Highlands in the west of the State, between the Wannon and the upper branch of the Glenelg. They consist of the granitic masses and old schists about Wando Dale and Nareen.

(2) The granitic mass between the Grampians and the Victoria Range, round the source of the Glenelg.

(3) The granitic rocks between Ararat and Moyston.

(4) East of Ararat is a series of granitic masses belonging to the Primitive Mountain Chain, and forming the Southern Pyrenees. It extends from Larne Gerin on the west to Lexton on the east, and includes Mount Buangor, Mount Cole, Amphitheatre, and Lexton.

(5) East of the basalt plain at the head of the Bet-Bet Valley are the granitic hills around Clunes, including Mount Bolton, Mount Misery, and Mount Beckwith.

(6) Near Clunes the Primitive Mountain Chain takes a sharp bend to the north-east. Its next fragment is the granitic mass of Rodborough.

(7) On the eastern side of the Loddon Valley the Primitive Mountain Axis is conspicuously represented by the granitic range which extends past the western foot of Mount Tarrengower through the Harcourt Ranges, south of Bendigo, near Ravenswood, to Mount Alexander. This group ends to the east, in the valley of the Coliban and the Campaspe.

(8) East of these rivers are the Cobaw and Mollison Creek Ranges, which belong to the Primitive Mountain Chain.

(9) The next representative is on the eastern side of the Seymour-Kilmore Valley. It begins with Breach Peak, and continues through the Strathbogie Ranges into Delatite.

(10) Then follows Mount Buffalo. Here the mountain line has been bent to the north, owing to the resistance of the old crystalline rocks of Bogong.

(11) Mount Stanley is the next member that may belong to the Primitive Mountain Chain.

(12) The last group in Victoria is formed by the granites of Northern Benambra.[2]

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[1] J. W. Gregory, *The Geography of Victoria*, pp. 73-75.

[2] Whether Nos. 10-12 belong to this series is somewhat doubtful.

To the south of the Great Valley of Victoria there are the remains of two mountain lines which trended east and west. The younger and more conspicuous of these was composed of Jurassic mudstones, which have now been separated by denudation into disconnected blocks: the Wannon Hills on the west, the Otway Ranges, the Barabool Hills near Geelong, and the South Gippsland Hills. The less conspicuous mountain line has been named the Bunurong Range, and is composed of a series of granitic massifs and some associated Heathcotian and Silurian strata. This range is composed of four disconnected fragments—the granitic massifs (1) of Cape Woolamai; (2) of Wilson's Promontory; (3) of Cliffy Island, Hogan Island, and the Kent Islands in Bass Strait; and (4) the Archean rocks of Cape Waratah.

3. The Rivers of Victoria

The evolution of the river system of Victoria has been sketched by the author in the *Geography of Victoria* (pages 127 to 193). The present arrangement of the rivers depends on the fact that most of Victoria consists of an ancient plateau, the surface of which is a dissected peneplane, with the highest ridge on the northern side overlooking the Murray basin. A series of consequent rivers accordingly flowed down the slope to the south into the Great Valley of Victoria. Short obsequent rivers flowed down the northern face of the plateau into the Murray. The existing river system has been developed by the growth of subsequent rivers, along lines determined by the geological structure of the plateau. The heavy rainfall on the mountains of north-eastern Victoria has enabled the rivers flowing northward, such as the King River, to cut their valleys far southward.

Photo. *A. E. Kitson.*

THE KING RIVER, NEAR EVANS CREEK JUNCTION, IN THE HIGHLANDS OF NORTH-EASTERN VICTORIA.

Accordingly, many of the head-streams that once discharged into the Great Valley of Victoria have now been captured by the tributaries of the Murray. The most important of the subsequent rivers is the Goulburn, which has worked its way backward round the southern end of the Strathbogie Mountains, and diverted the rivers that once flowed southward through the air-gaps on the present main divide, to the north of the Yarra River. Thus Reedy Creek, King Parrot Creek, the Yea River, and the Acheron River have been diverted from the Yarra basin into the Goulburn, and through it into the Murray. The same action in north-eastern Victoria has enabled the Mitta-mitta, Kiewa, and Buffalo Rivers to capture the heads of rivers that discharge southward into the Latrobe; and at the same time the highest peaks of Victoria, Mounts Bogong and Feathertop, have been left isolated, to the north of the present divide.

In western Victoria the wandering of the divide [1]

[1] The main watershed is called the "Main Dividing Range," a term which dates from a Proclamation of 29th December 1848, published in the *Government Gazette* of 10th January 1849, p. 12. Some biologists have regarded this line as an important and ancient biological boundary. Thus Mr. J. A. Campbell, in discussing the distribution of the Victorian magpies, remarks the occurrence of the southern species to the north of the Divide beyond Castlemaine (*Proc. R. Soc. Vict.*, vol. vii., New Series, 1895, p. 205). Mr. D. Le Soeuf has correctly pointed out that this line is of no precise value as an ornithological boundary. Other biologists, however, have used the term "Great Dividing Range" for the whole of the mountainous Highlands of Victoria, which are of course of great antiquity, and separate distinct biological areas. But the Victorian Highlands are a very different thing from the Great Dividing Range, which is a line of geologically recent origin, is still slowly migrating, and traverses areas both sides of which are often biologically identical. This irregular line is of no biological importance, except for the limited part of its course, where it happens to coincide with the axis of the Victorian Highlands, as it does where they are narrowest. It is of only secondary value in physical geography, as the chief mountains of Victoria do not occur on it. It separates the northern and southern

has been no less marked, and has there been largely due to volcanic disturbances, which have built up dams across the former courses of the rivers. Thus the Loddon leads, which are now being worked for gold, were deposited by a river that rose in the range south of Ballarat; the outlet to the north was dammed across by the lava-flows

Photo. *A. E. Kitson.*

THE LATROBE RIVER, NEAR MORWELL.
On the floor of the Great Valley of Victoria.

north of Ballarat and near Creswick; and thus part of the original northern drainage has been captured by the Yarrowee, and now flows into Port Phillip.

The Latrobe is a subsequent river, and its lower part is due to the filling up of the former Gippsland

drainage; its main importance is as a term in political geography. As a mountain range, it belongs to a similar category to that which Spencer has dismissed as "the *so-called* coastal range" (*Northern Tribes of Central Australia*, p. 8), which bounds the coast-plain of the Gulf of Carpentaria.

estuary, whereby several rivers, the Moondara, Thomson, Macallister, Mitchell, Nicholson, and the Tambo, all discharge to the sea through the single outlet known as Lakes' Entrance. Further east is the mouth of the Snowy River, which rises in New South Wales, crosses the eastern province of Victoria and discharges to the

Photo. A. E. Kitson.

THE JUNCTION OF THE BUCHAN AND MURRINDAL RIVERS.
In the Eastern Highlands of Victoria.

Southern Ocean at Orbost. Its chief tributary is formed by the junction of the Buchan River and the Murrindal River, both of which rise in the hills of Tambo.

The chief river system of north-western Victoria is the Wimmera, which originally consisted of three independent rivers flowing from south to north. The Upper Wimmera drained the northern slopes of the Grampians,

and continued northward through Snakes River and the Avon River into Lake Buloke. Most of its upper drainage has now been carried westward into the valley of an originally independent river, the Yarriambiack Creek, that flows northward into Lake Coorong. The westernmost of the three rivers begins at Norton Creek, and, after passing Natimuk, flows into Lake Hindmarsh, and thence through Outlet Creek into Lake Albacutya. These two lakes now receive all the drainage of the northern Grampians and Victoria Ranges, which was once more widely distributed through the Wimmera district; and owing to the high evaporation on these north-western plains, the total discharge from the Wimmera river evaporates in the lakes, and this river basin is now an area of internal drainage.

The volume of the rivers is known with unusual completeness, thanks to the careful observations made under the supervision of Stuart Murray by the officers of the Water-Supply Branch of the Victorian Mines Department.

The results, up to the end of 1900, are given in *River Gaugings, a Complete Compilation of Results from the commencement of the work to the end of the year* 1900 (Melbourne, Victoria, 1901, 122 pp., 3 plates).

The following list includes the chief rivers, and shows their volumes and the proportion of the rainfall on their basins that they discharge :—

[TABLE

River.	Drainage Area. Sq. Miles.	Year.	Rain-fall on Drain-age Area in Ins. for Year.	Total Annual Discharge in Cubic Feet.	Propor-tion of Total Rain-fall dis-charged per cent.
Murray at Mildura .	92,000	1870	15	1,141,728,000,000	5·4
		1897	17	198,441,000,000	7·1
		1900	23	355,053,000,000	7·57
Murray at Echuca .	19,400	1870	...	457,167,000,000	...
		1896	27	152,480,000,000	13
		1900	32	249,944,000,000	18
Murray at Albury .	6,470	1884	...	78,697,000,000	...
		1894	46	264,383,000,000	38
		1900	37	143,654,000,000	26
Murray at Jingellic .	2,520	1894	48	152,991,000,000	55
		1900	36	89,997,000,000	43
Mitta at Tallangatta .	1,990	1894	44	87,987,000,000	43
		1896	31	32,517,000,000	23
		1900	36	51,309,000,000	31
Kiewa at Kiewa . .	434	1887	65	27,438,000,000	42
		1896	54	12,703,000,000	23
		1900	65	20,534,000,000	32
Ovens at Wangaratta .	2,090	1888	36	25,464,000,000	15
		1894	59	82,948,000,000	29
		1900	47	47,605,000,000	21
King River at Wangaratta	620	1889	60	14,008,000,000	16
		1897	34	4,453,000,000	9
		1900	40	7,124,000,000	12
Broken River at Casey's Weir, Goorambat	730	1894	47	23,104,000,000	29
		1896	29	3,554,000,000	7
		1900	33	6,886,000,000	12
Goulburn at Murchison.	3,966	1884	29	50,963,000,000	19
		1887	52	167,625,000,000	35
		1900	42	88,784,000,000	31
Campaspe at Rochester .	1,362	1886	25	2,367,000,000	3
		1889	36	17,252,000,000	15·2
		1900	24	6,351,000,000	8
Loddon River at Bridgewater	1,856	1888	$15\frac{3}{4}$	4,641,000,000	6·8
		1889	$31\frac{3}{4}$	18,706,000,000	13·7
Loddon River at Laanecoorie Weir	1,590	1900	23	7,536,000,000	9·1
Avoca River at Coonooer Weir	1,029	1893	26	7,279,000,000	11·8
		1896	15	106,000,000	·3
		1900	17	671,000,000	1·7
Wimmera River at Glenorchy Weir	768	1894	31	6,169,000,000	11·2
		1896	18	408,000,000	1·3
		1900	20	1,521,000,000	4·2

River.	Drainage Area. Sq. Miles.	Year.	Rain-fall on Drain-age Area in Ins. for Year.	Total Annual Discharge in Cubic Feet.	Proportion of Total Rain-fall dis-charged per cent.
Wimmera River at Horsham	1,530	1893	26	19,386,000,000	21·3
		1896	17	148,000,000	·2
		1900	19	3,704,000,000	5·5
Mackenzie River at Wartook Reservoir	29	1900	31	847,000,000	41
Glenelg River at Mooramoora	166	1889	44	3,989,000,000	24
		1890	32	2,388,000,000	20
Glenelg at Balmoral	606	1889	41	11,190,000,000	19
		1897	22	814,000,000	2·6
		1900	24	3,883,000,000	11·4
Mather's Creek at Balmoral	78	1889	36	1,221,000,000	19
		1891	24	96,000,000	2·2
Yarra at Warrandyte	972	1894	47	42,719,000,000	41
		1898	35	16,908,000,000	21
		1900	45	41,481,000,000	41
				Gallons.	
Coliban River at Malmsbury Reservoir	112	1900	33	13,867,000,000	27

4. The Lakes of Victoria

Victoria has an extensive series of lakes, which belong to five groups. The first group comprises lakes in shallow depressions on the lava plains of south-western Victoria. The largest of them is Lake Korangamite, 20 miles long from north to south, and from 3 to 6 miles wide; it has an area of 72 square miles. The Surveyor-General's map of Victoria shows 145 lakes in this part of the Great Valley of Victoria. Many of the lakes, such as Lake Kolungulac, are salt, and sometimes their beds are dry. In the same district there are a series of small round lakes which are often deep, such as Lakes Bullen-merri and Gnotuk, to the west of Camperdown.

Lake Bullen-merri, of which the water is fresh, is 270 feet deep, while the adjacent Lake Gnotuk, about 110 feet deep, is very salt. Lake Bullen-merri is fresh, as it has an outlet by percolation into Lake Gnotuk. These lakes have been described as crater lakes; but, according to the author, their basins are not true volcanic craters, but volcanic caldrons, or "caldera," formed by the subsidence of blocks of ground left unsupported in consequence of volcanic eruptions. Tower Hill, near Koroit, Lake Terang, and Lake Keilambeit also occupy volcanic caldrons. Tower Hill has an island with a well-preserved volcanic crater in the centre of the foundered area.

The second group of lakes occurs in north-western Victoria, on the plains of the Wimmera. They occupy shallow depressions, some of which may have been formed by wind erosion. Others are the expansions of river valleys, dammed up by accumulations of silt, through which the diminished rivers have no longer been able to cut their way. Others, such as Lake Boort, are probably due to the removal of subterranean beds by solution.

The Gippsland lakes are the most picturesque in Victoria, and they are the remnants of an old estuary. The formation of the Ninety Mile Beach by shore action led to the gradual silting up of the lagoon behind it. The ingrowth of the shores of the lagoon is steadily reducing the area of these lakes, and banks, formed beside the river mouths, have cut up the once continuous sheet of water into smaller lakes. The Mitchell River is building up silt jetties projecting into Lake King, and they will in time divide that lake into several smaller "broads," some of which will ultimately be completely separated from the rivers, as is already the case with Lake Kakyora.

The fourth group of lakes occurs in the river flats beside the Murray and its tributaries. They are cut-off arms and meanders of the river. These cut-off lakes, known by the aboriginal name of Billabongs, are especially well seen along the Murray near Rutherglen. But they are widely distributed through Victoria along the banks of the Murray and its chief tributaries. They are sometimes crescentic in form, and may occur some distance from the present course of the rivers. They are sometimes called "anabranches," an abbreviation of the term "anastomosing branches" proposed in 1834 by Colonel Jackson, though it is often regarded as an aboriginal name.[1]

Along the banks of the Murray there are also many shallow lakes, due to the spreading out of the water of the streams which have been cut off from the Murray by the raising of its flood-plain. These lakes are well shown along the lower part of the Loddon River, near Kerang.

Mountain tarns and lakes are scarce, owing to the rapidity with which they are drained by the rapid corrosion of the rivers. Nearly all the Victorian lakes are therefore at low levels. The most interesting of the mountain tarns is Lake Karng on Mount Wellington, the basin of which has been described by Dr. Howitt as moraine-dammed; by Professor Denny as due to a landslip; and by Mr. A. S. Lucas as a hollow, worn out by river erosion.

[1] The formation of these cut-off lakes is illustrated by reference to those now in process of formation near Seymour in the *Geography of Victoria*, p. 146, which shows the variation in the Goulburn River, according to maps of 1841, 1855, 1859, 1902.

5. The Extinct Volcanic Craters

Volcanic activity in Victoria has left a varied series of fine volcanic craters, many of which are remarkably fresh, showing that eruptions have taken place in times geologically quite recent. The best preserved is Tower Hill, near Warrnambool, on the southern coast; the most recent crater there occurs on an island in a lake formed by subsidence. Mount Noorat has one large central crater, surrounded by four secondary craters. Mount Franklin is a well-preserved crater, almost on the summit of the present divide. It is breached by a lava-flow, which came out on the south-eastern side. Warrenheip, the best preserved crater near Ballarat, has been breached by a lava-flow to the north-west. Mount Buninyong, one of the most conspicuous peaks between Ballarat and Geelong, is less regular, having had a double centre of eruption, while the crater walls are more denuded than those of Mount Warrenheip. Mount Elephant is the best and largest of the simple craters in the central division of the volcanic plains; it has been breached on the northern side, and a secondary centre of eruption formed in the breach.

It has been claimed that the latest of these eruptions were contemporary with the human occupation of Victoria. The author has recently discussed this question,[1] and maintained that there is no evidence to show that the aborigines arrived in Victoria before the last of these eruptions.

[1] "The Antiquity of Man in Victoria," *Proc. R. Soc. Victoria*, vol. xvii. (New Series), 1904, pp. 120-144.

6. The Geology of Victoria

The geology of Victoria is more complex for the size of the territory than that of any other State on the mainland of Australia.

The dominant fact in its geological structure is that it consists of a base of Lower Palæozoic and Archean rocks, which have been thrown into a series of folds along two lines. The axes of the older series of folds trend from north to south; those of the second series, formed in Upper Palæozoic times, run from east to west. Both mountain systems have been cut down into a series of low-lying plains, which were elevated into plateaus, and then intensely dissected by the rivers. The continuity of the fragments of the old plateau has been broken by the foundering of great earth blocks. The dominant features in the geography of Victoria at the present time are due to these subsidences. Thus, a great regional sinking has formed the Murray basin; faulting downward, along sharply-defined lines, has formed basins, some of which are widely open to the sea, as in the triangular area of lowland let into the Gippsland Hills north of Anderson's Inlet; others are nearly closed basins, such as that to the north-west of Geelong, separated from Port Phillip by the basalt-capped ridge east of the Moorabool River. Smaller subsidences formed the volcanic caldrons of the Hampden district, which have been described as volcanic craters, and a caldron near Daylesford.

The oldest rocks of Victoria are of Archean age. They consist of two blocks of gneisses and schists, which form the Highlands of Dundas in the west, and the whole of the north-eastern part of Victoria, including most of the counties of Benambra and Bogong. These rocks

have been described as altered Silurian rocks, but it has been shown that Ordovician slates and grits rest unconformably upon their flanks. They are unquestionably pre-Ordovician, and later observations in the neighbourhood of Mount Buller leave no doubt that they are pre-Cambrian.

The foundation of Central Victoria consists of a framework of rocks, known as the Heathcotian series, which are also of pre-Cambrian age. The Heathcotian series consists of phyllites, schists, foliated diabases, and amphibolites, and beds of chert or jasperoid and some volcanic agglomerates. These rocks are exposed in Victoria in a few localities. They form the whole of the Colbinabbin Range eastward from Bendigo, and the rocks extend southward along the Mount William Range. They are exposed at Dookie, and the diamond drill borings of the Victorian Mines Department show that these rocks underlie the Silurian rocks of Rushworth. The Heathcotian cherts outcrop at Mount Stavelly, at the foot of the Grampians. They have been apparently reached by a bore which pierced the Jurassic coal-measures near Korumburra; and judging by the great abundance of the cherts in the gravels of South Gippsland, they probably were widely exposed in the old Bunurong Range, which at no distant date was continuous between Wilson's Promontory and Western Port, to the south of the present coast-line.

The only Cambrian rocks yet proved in Victoria are near Mansfield, where A. M. Howitt has collected some fossils belonging to the genera *Olonellus* and *Salterella,* associated with phosphatic limestones and wavellite.

The Ordovician system is much better developed in Victoria than in any other Australian State. Its rocks were originally described as the Lower Silurian, but the

term Ordovician is now accepted by the Geological Survey as well as by most of the unofficial geologists. The Ordovician rocks consist of slates, quartzites, and grey-wackes, most of which have been cleaved, and their fossils destroyed. Some masses of slates and unfossiliferous rocks, such as those of Ballarat and parts of the Pyrenees, and the schists around the granites of Ararat, are still included in the Ordovician, but may be of earlier age.

The Ordovician sequence in Victoria has been classified by T. S. Hall into four divisions:—

Upper Ordovician . .	Darriwill series.
Lower Ordovician . .	Castlemaine series.
	Bendigo series.
	Lancefield series.

Their best-known fossils are the graptolites, of which there is a fairly rich fauna. They indicate some mixture of faunas when compared with those of Europe; for in the Lancefield beds there are *Diplograptus*, and other fossils suggestive of Cambrian age, associated with *Lasiograptus*, which is typical rather of the Upper Ordovician.

The Ordovician deposits have been laid down in a sea which extended across Eastern Victoria from the Gippsland Lakes to the valleys of the Ovens, and Broken Creek, tributaries to the Murray. To the south was a great land area, which extended along the southern coast from Wilson's Promontory to Western Victoria. In the west the Ordovician land projected northward again, past the site of the Stavelly Range, and included the districts now covered by the Grampians and the county of Dundas. To the east of this land, excepting the Colbinabbin and Mount William Ranges, the Ordovician Sea covered the rest of Western Victoria, including the Goldfields of Bendigo, Castlemaine, and Ballarat, and probably extending

southward as far as Lake Korangamite. The Ordovician beds were laid down in transgressive series, gradually spreading over the shores of this sea basin. The Lancefield beds rested upon the flanks of the Mount William Ranges. The Lancefield beds were covered by the wider sheet of the Bendigo beds, which in their turn were overlaid by the Castlemaine beds. An extension of the marine transgression led to the deposition of the Upper Ordovician of Wombat Creek in Benambra, and across the Victorian border in the adjacent parts of New South Wales.

The Silurian beds are divided into two series: the Lower or Melbournian consists in the main of sandstones, quartzites, and shales; and the Upper or Yeringian series includes shales, sandstones, and limestones. The limestones are much rarer in Victoria than in New South Wales. The limestones occur in ellipsoidal masses, as at Lilydale, Loyola, Waratah Bay, and the Thomson River. They are rich in fossil corals, while the accompanying shales and sandstones contain abundant brachiopods and mollusca.

The Devonian rocks of Victoria are divided into three series—Lower, Middle, and Upper—which all occur in Eastern Gippsland and Croajingolong.

The Lower division is best represented by the porphyries and associated igneous rocks to the east of the Snowy River. They represent the stumps of an old chain of volcanoes, which in Lower Devonian times extended north and south across Eastern Victoria.

The Middle Devonian was a period of marine transgression. The sea occupied gulfs in eastern Victoria, in which were formed the limestones of Buchan and Bindi, and the richly fossiliferous Tabberabbera shales of the Mitchell River. The Upper Devonian rocks are a series of sandstones and conglomerates. The fossiliferous sandstones of this division are named from the locality

where they are best developed, the Iguana Creek Beds. Associated with them are coarse conglomerates, which occur near Mansfield. The Devonian, as a whole, must have been a period of intense earth-movement. Thus a series of powerful folds affected the Victorian rocks at the close of the Lower Devonian. Another series of disturbances occurred at the close of the Middle Devonian. The Upper Devonian beds are more horizontal than those of the Lower Devonian.

The Carboniferous system is represented in Victoria by beds of great interest, but of less economic value than in New South Wales. This system is represented by three types of deposits.

The Lower Carboniferous beds are a series of coarse sandstones, developed along the Avon River, which contain the plant Lepidodendron, and no doubt correspond to the Lepidodendron beds of New South Wales and Queensland. These sandstones extend in a band trending northward across Central Gippsland to Mansfield, where they have yielded a fauna of Lower Carboniferous fish, mainly collected by Mr. George Sweet.

The Grampian sandstones, the Cathedral sandstones, and those of the Mount Wellington district, though unfossiliferous, are probably also to be regarded as of Lower Carboniferous age.

The Upper Carboniferous is represented by the famous glacial deposits and boulder clays of Bacchus Marsh, Heathcote, Bendigo, the Loddon Valley, and Southern Gippsland. These beds are unquestionably of glacial origin, as they contain polished and ice-scratched boulders, and rest upon rock surfaces which have been ground and worn by ice-action. The boulder beds are associated in places with lake deposits; but as a whole they are unstratified tills. They have not yielded any

Photo. H. J. Grayson.

A ROCK SURFACE ON COIMADAI CREEK, NEAR BACCHUS MARSH, POLISHED BY CARBONIFEROUS GLACIERS.

contemporary fossils, and appear to have been laid down in a series of basins and valleys on the flanks of the great mountain range which then extended east and west across Victoria.

The glacial beds of Bacchus Marsh are overlaid by a series of sandstones which contain the leaves of *Gangamopteris*, and are therefore to be correlated with the Gangamopteris beds in the Carboniferous of New South Wales. Kitson's work on the glacial beds of the northern coast of Tasmania shows that they are on the horizon of the Greta or Lower Coal-measures of New South Wales. The glacial beds of Victoria may be safely regarded as of approximately the same age.

The Permo-Carboniferous deposits of New South Wales with their rich coal seams have not been discovered in Victoria.

The Mesozoic group is represented only by rocks of the Jurassic period. They form the Wannon Hills in Western Victoria, the Otway Ranges, the Barabool Hills, and the hills of Southern Gippsland. The rocks are sandstones, mudstones, and shales. They contain many fossil land-plants, occasional fish and reptile remains, and are, no doubt, of terrestrial and fresh-water origin. In South Gippsland they contain seams of coal of an excellent quality, which is worked in mines at Outtrim, Jumbunna, and Korumburra. The rocks consist mainly of volcanic debris, chiefly of basic character, and they have been formed by the wearing away of a great area of volcanic rocks, possibly a northern extension of the dolerite plateau of Central Tasmania. The drainage during the deposition of these Jurassic beds appears to have been from south to north; and the coal deposits may have been laid down in a series of swamps, a little to the south of the present position of the Great Valley of Victoria.

The Cainozoic beds begin with a series of clays containing thick deposits of brown coal, which occur under the Mallee Plains, and at intervals along the Great Valley of Victoria. Near Melbourne a thick seam of brown coal occurs at Point Cook. The greatest development of the brown coal is in Southern Gippsland, where the tributary valleys from the hills join the Great Valley, and especially in the basin of the Latrobe. Some of the bores have proved an enormous thickness of brown coal, and one cliff face on the banks of the Latrobe shows a thickness of 90 feet of it. The precise age of these beds has not yet been accurately ascertained, but they are either Oligocene or Eocene. The brown coal series was followed by the deposition of a marine series of beds—limestones, clays, and sandstones—which extend along the southern coast, and run in a series of gulfs northward into the country. Near Melbourne these marine beds extend as far north as Green Vale, near Keilor. They occur up the valley of the Barwon and Moorabool, and extend round the flanks of the Otway Ranges, and up the southern slopes of the Ballarat Plateau. In eastern Victoria they occur at the foot of the Victorian Highlands, and underlie the Gippsland Lakes, and can be traced at intervals from Orbost, on the Snowy River, westward to Alberton. Wilson's Promontory and the country westward as far as Western Port was then a highland, and projected south-eastward to join Tasmania. The age and classification of these marine beds have been greatly discussed. The evidence of the more valuable diagnostic fossils, such as the fish, mammals, and echinoids, suggests that the chief horizon is either Upper Oligocene or Miocene. Associated with these Middle Cainozoic beds are a series of lavas—the older Victorian basalts. They are widely distributed in

Victoria, and were discharged from a series of eruptions from vents scattered across the Western Plains, and near Melbourne. Other fragments of them remain on the tablelands of the Australian Alps, from the Snowy Plains of Dargo, to Kiandra in New South Wales. They were succeeded by basalts of a later period, which also spread out in broad sheets of lava, which have been much less denuded and decomposed. Still later occurred another series of volcanic eruptions, which piled up the existing craters, such as Mount Elephant, Mount Noorat, Tower Hill, Warrenheip, etc. The number of volcanic vents of which the remains occur in Victoria is very considerable. The most conspicuous belong to the later series of eruptions. The best exposed vent of the older basaltic eruptions is the deeply dissected stump of an old volcano 2 miles north-west of Bacchus Marsh; and old vents still more denuded occur on the Western Plains, near Camperdown and Mortlake. Later marine Cainozoic rocks occur in Western Victoria along the valley of the Glenelg. Associated with some of the volcanic rocks are lake deposits and volcanic tuffs, in which occur the bones of giant marsupials, which have been found at Kolungulac, near Geelong, near Castlemaine, etc. The formation of the hills of dune limestones and sandstones along the Victorian coast began at the same period. Those at Sorrento Peninsula have yielded the remains of giant marsupials. To the same date belong the silts of the North-Western Plains, which gradually filled up an old arm of the sea, that once entered the Murray basin from the southern coast. The highest point at which the marine deposits of this gulf have been found is in some auriferous deposits in the neighbourhood of Stawell. The younger basalts covered many of the river valleys, especially those which flowed

northward into the Murray basin from the Ballarat Plateau. These deep gravels of the old Loddon are now being worked for their alluvial gold.

7. Economic Geography

1. *Pastoral and Dairying Industry.*—The permanent active colonisation of Victoria dates from the beginning of its pastoral occupation in 1835,[1] when John Batman arrived on behalf of the Port Phillip Association, and Fawkner's party, in August of that year, founded Melbourne. From this settlement and from Geelong, which was founded a little later, the whole of Victoria, suitable for occupation at that period, was taken up between 1836 and 1846. Pastoral settlements were distributed throughout the State, except in the mountainous highlands of Gippsland, the Otway Ranges, the north-eastern provinces, and Croajingolong. But some settlements were made even amongst the mountainous highlands, as at Omeo in 1839; while some of the southern parts of the Mallee country were occupied in 1845 and 1846.[2]

The pastoralists introduced great flocks of sheep, which soon grew rapidly in number owing to the excellent pasture and the favourable climate. The wool ranks amongst the most valuable grown in the world, and the Victorian yield is on average worth 20 per cent more than that of any other State in Australia. The

[1] The earlier settlements, whether pastoral, whaling, or sealing, had all been temporary, with the exception of the Hentys' whaling station at Portland, founded in 1834.

[2] A sketch map, showing the dates of the pastoral occupation, is given in the *Geography of Victoria*, p. 252. The original data are given in *Letters from the Victorian Pioneers*, edited on behalf of the Melbourne Public Library by Dr. T. F. Bride. Government Printer, Melbourne, 1898, pp. xiii. and 325.

number of sheep in 1903 was estimated at 8,774,731, and the quantity of the wool produced was 54,608,582 lbs.

The agricultural and dairying industries developed later than the pastoral. The highlands of eastern Victoria are best suited for cattle runs, and many of the large sheep stations on the western plains of Victoria have now been divided into dairy farms. In many cases the tenants pay their rent not in cash, but in milk. The milk is delivered to a central co-operative butter factory. Each farmer is credited with the cream contents of his milk, calculated from the amount of his daily delivery, and its quality, which is determined by a simple chemical test, once a week, of a sample made up from a sample of each day's milk supply. The rent charge and the expenses of the butter factory are then deducted from the farmer's credit.

In 1903, 46,685,727 lbs. of butter and 5,681,515 lbs. of cheese were produced in Victoria.

The system of co-operative dairy farming has contributed greatly to the prosperity of Victoria. The distribution of this industry, as shown in the following table, from the "Statistical Register of the State of Victoria, for the year 1903," is a useful index to the agricultural condition of different parts of the State.

[TABLE

District and County.	Cow Keepers.	At the time of the Collector's visits.		Milk produced during the year 1903 (so far as returned).		Number of Cream Separators used.
		Number Total.	Number whose Milk was recorded.	Quantity returned.	Average per cow.	
				Gallons.	Gallons.	
Central District.						
Bourke . . .	3,162	39,503	18,321	6,007,276	327·89	729
Grant	2,309	19,524	3,958	1,101,771	278·36	589
Mornington . .	2,089	34,061	6,945	2,257,058	324·99	922
Evelyn . . .	1,227	9,819	1,664	439,965	264·40	188
North Central District.						
Anglesey . . .	564	11,665	1,023	308,243	301·30	104
Dalhousie . . .	1,201	12,361	3,550	1,003,131	282·57	262
Talbot . . .	2,332	13,560	953	232,475	243·94	416
Western District.						
Grenville . . .	993	12,008	1,471	566,104	384·84	180
Polwarth . . .	912	16,936	2,349	714,415	304·14	238
Heytesbury . .	756	22,282	7,502	2,836,700	378·81	15
Hampden . . .	606	27,303	14,647	6,038,425	412·27	18
Ripon	493	2,590	...	...	...	51
Villiers . . .	1,445	24,877	2,261	813,270	359·69	16
Normanby . . .	1,008	11,314	2,828	893,169	315·81	133
Dundas . . .	543	3,432	207	63,584	307·17	59
Follet	207	1,507	3	1,095	365·00	27
Wimmera District.						
Lowan . . .	1,196	4,392	...	...	...	89
Borung . . .	1,961	7,147	186	49,540	226·34	143
Kara Kara . . .	1,149	4,217	64	12,955	202·42	38
Mallee District.						
Millewa . . .	...	...	...	...	...	...
Weeah . . .	58	146	...	...	...	...
Karkarooc . . .	658	2,125	134	56,242	419·72	38
Tatchera . . .	885	6,124	513	169,728	330·85	161
Northern District.						
Gunbower . . .	734	9,057	1,082	374,2[illegible]3	345·87	427
Gladstone . . .	1,029	3,652	182	40,568	222·90	46
Bendigo . . .	1,438	8,385	505	176,864	350·23	207
Rodney . . .	1,285	11,010	636	205,956	323·83	357
Moira	2,694	29,305	4,328	1,102,838	260·23	481
North-Eastern District.						
Delatite . . .	1,443	28,236	10,332	3,668,871	355·10	131
Bogong . . .	1,379	19,277	2,018	545,545	270·34	206
Benambra . . .	433	6,391	...	...	...	19
Wonnangatta . .	121	1,139	360	100,903	280·29	22
Gippsland District.						
Croajingolong . .	198	2,735	...	...	...	12
Tambo . . .	200	2,503	295	74,800	253·56	27
Dargo	321	4,321	197	41,615	211·24	121
Tanjil	1,129	23,900	3,142	867,368	276·06	250
Buln Buln . . .	3,586	78,375	3,592	1,231,284	342·79	2,264
Total . .	41,824	515,179	95,158	31,995,901	336·24	8,986

NOTE.—In 49 urban municipalities 1880 dairies, and in 96 shires 11,786 dairies were reported to have been registered, but in the remainder the system of registering does not appear to have been adopted.

Milk—quantity returned.—Many of the farmers could not supply the information. The yield of private cows, etc., is not taken into account.

2. *Agriculture.*— Agricultural development has followed the spread of the railways. The chief crop is wheat, for which, if the rain falls at suitable seasons, the rich calcareous soils of the Mallee country are well adapted. The Victorian soils are, however, poor in phosphates, and the yield per acre is therefore low. The use of superphosphates is, however, spreading, with results shown in the following comparison obtained in the season of 1903-1904.

RESULTS OF WHEAT MANURING IN PORTIONS OF WHEAT-GROWING COUNTRIES, 1903-1904.

Manured—Area	214,798 acres.
Produce	3,021,553 bushels.
Average per acre	14·7
Not manured—Area	165,939 acres.
Produce	1,856,332 bushels.
Average per acre	11·9

The total produce of wheat for the past four years in the following table shows the low average in bushels per acre, as well as the disastrous effect of the drought of 1902, in the yield for 1902-3.

PRODUCE OF WHEAT IN VICTORIA.

Year.	Number of Bushels.	Return in Bushels per Acre.
1900-1	17,847,321	8·85
1901-2	12,127,382	6·91
1902-3	2,569,364	1·29
1903-4	28,525,579	14·49

The poor soils of the Silurian districts are utilised for orchards; the rich volcanic soils on the older basalts, as near Warnambool and the Bellarine Peninsula, yield rich crops of potatoes and onions. Vines grow well on the northern slopes of the hills in the Murray basin; and much excellent wine is produced there and in the Upper Yarra around Lillydale.

The extent of land occupied and cultivated with various crops in Victoria during 1903-1904 was as follows:—

	Acres.
Total area cultivated	4,021,590
Wheat	1,968,599
Oats	433,638
Barley	47,760
Maize	11,810
Rye	2,021
Pease and beans	8,960
Potatoes	48,930
Mangel-wurzel	1,564
Beet, parsnips, carrots, and turnips	1,014
Onions	4,176
Hay	733,353
Green forage	33,165
Grass and clover seeds	2,749
Hops	214
Tobacco	129
Vines	28,513
Other crops	2,662
Gardens and orchards	59,812
Land in fallow	632,521
Artificial grass	962,665

There are still large tracts of land in Victoria which appear to be suitable for agricultural settlements, as along the banks of the Murray. The sparsely occupied country in eastern and north-eastern Victoria is covered with dense forests, and the land is in most cases too far from railways to pay for clearing at the present time.

Photo. *A. E. Kitson.*

BRUTHEN, A COUNTRY TOWN, ON THE FLATS OF THE TAMBO RIVER, IN EASTERN VICTORIA.

8. Mining

Mining began in 1851. Gold had been found previously, but, so far as possible, its discovery had been kept secret from political motives. The earliest discovery of first-class mining importance was at Golden Point, Ballarat, in August 1851; and before the close of that year the goldfields of Mount Alexander (Castlemaine) and Bendigo, and most of the chief fields in that part of Victoria, had also been discovered. The existence of coal had been known since 1825, and even earlier, from the outcrops along the southern coast to the east of Western Port; but the active development of the coal-fields dates from about 1870. The Victorian black coal is of very excellent quality, but the seams are intensely faulted, and mining is therefore troublesome. The most successful mines in South Gippsland are at Korumburra, Jumbunna, and Outtrim. Seams of coal occur along the Bass Range, which runs south-westward from the chief coal-mining centre towards Western Port; but hitherto, owing to the expense of transport in that hilly district, the mines have been severely hampered by the competition of the more easily worked coal seams on the coast of New South Wales. In 1903, 64,200 tons of coal were raised in the State, and the total recorded to the end of that year was 2,237,258 tons.

The gold yield of over £260,000,000 which has been wrought from the State of Victoria, led to its rapid development and prosperity.

The gold yield of the mining districts in 1903, and the number of gold miners employed in each at the end of 1903, were as follows:—

Mining District.	Ozs.	Miners employed.
Ballarat	174,816	4,932
Beechworth	116,886	4,654
Bendigo	224,747	4,920
Maryborough	90,429	4,426
Castlemaine	74,323	3,672
Ararat and Stawell	31,230	1,640
Gippsland	61,787	1,608
Total	774,218	25,852

9. Manufactures

The manufactures are still mainly of articles of which local production is necessary; but there has been a considerable export of agricultural machinery to South America; and the local manufacture of woollen goods has been begun at Ballarat and Geelong. The rapid growth of the manufactures is shown by the following table, and their steady progress is confidently expected.

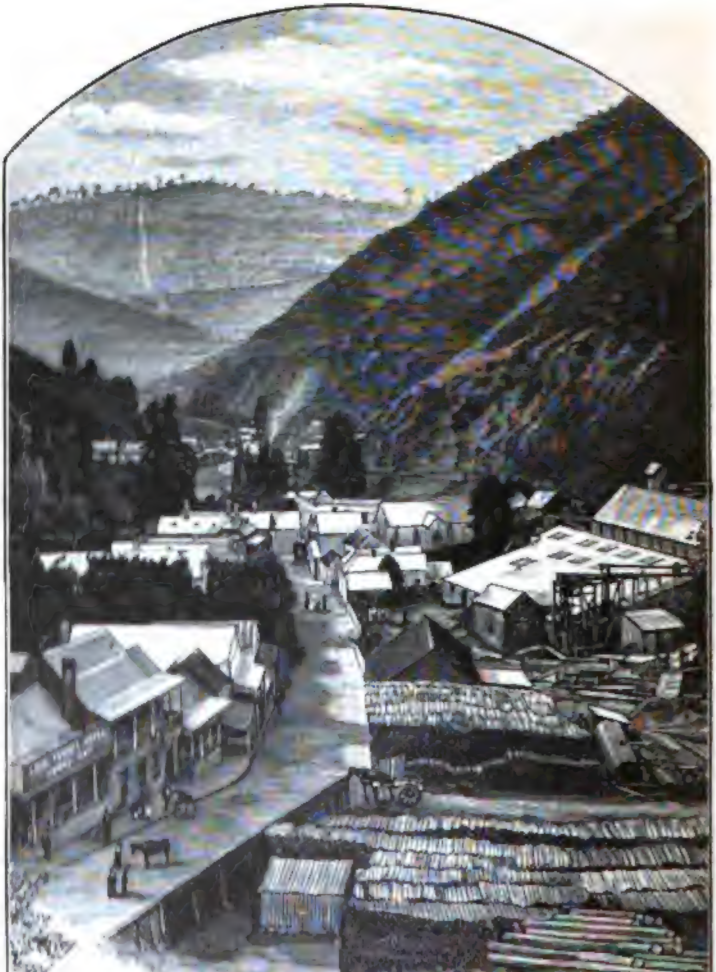
Number of hands employed in manufactories, works, etc.:[1]—

Year.	Hands employed. Total.
1891 (Census)	52,225
1899	60,070
1900	64,207
1901	66,529
1902	73,063
1903	73,229

10. Railways

The railways open in 1904 amounted to 3381 miles, mostly on the gauge of 5′ 3″. They were built at the

[1] "The Industrial and Factory Legislation" is explained by Harrison Ord in *The Law relating to Factories, Work-rooms, and Shops in Victoria.* Melbourne, 1900. 77 pages.



* GENERAL VIEW OF WALHALLA, A MINING TOWN IN THE HIGHLANDS OF VICTORIA.

total cost for construction and equipment of £41,216,703; the average cost of construction per mile has been £12,191. The average has been raised owing to the heavy cost of the early lines built—that from Melbourne to Bendigo having cost £50,000 per mile. The recent lines have been constructed with remarkable economy, the cost for construction being as low as £1500 to £2000 per mile for lines on a gauge of 5′ 3″. The first of the Victorian railways was a short line from Melbourne to the port at Hobson's Bay; and a second from Melbourne to Geelong in 1857. The railway line to Sydney through Seymour and Wangaratta was completed in 1873. The railway westward to Adelaide through Ballarat, Ararat, and Horsham to the frontier at Serviceton, was begun in 1874 and completed in 1887. The main eastern line goes from Melbourne along the Great Valley of Victoria, over the Drouin gap into the valley of the Latrobe, and along the northern margin of the Gippsland lake plain, to the present terminus at Bairnsdale. The Gippsland line goes south-eastward to the coalfields of Korumburra, and thence on to Corner Inlet and Port Albert. The south-western districts of Victoria are served by a line from Ararat to Portland, and by the line through Geelong, Colac, and Camperdown to the coast at Warnambool and Port Fairy. The mining fields of Ballarat, Castlemaine, and Bendigo are connected by minor branch lines; and from Maryborough and Bendigo three lines start north-westward into the Mallee Plains, to serve the great wheat fields of that district. A line, completed in 1904, traverses the whole width of the Mallee Plains of north-western Victoria to the irrigation settlement on the banks of the Murray at Mildura.

11. Water Supply and Irrigation

The future agricultural development of Victoria is largely dependent upon the possibilities of irrigation and on the available water supply. Irrigation settlements on a small scale, as at Bacchus Marsh and on the banks of the Murray at Mildura, have been very successful. The Mildura settlement was begun in 1887 by the Chaffey Brothers, but, owing to the remoteness of the locality from markets, and the cost of developing the 250,000 acres allotted to the settlement, the experiment was at first unsuccessful. After the failure of the Chaffey Brothers, the Government undertook the responsibilities of the settlement. It has been since connected by railway with Melbourne, and by the cultivation of raisins and other dried fruits the settlement has become an established financial success.

The water supply of Victoria is controlled in the main by the Water Supply Branch of the Mines Department, which conducts the national water-supply works and supervises the local Water Trusts and Irrigation Trusts. The Water Trusts control the water supply of the towns, while the Irrigation Trusts are authorised to take water from various rivers, for the purpose of irrigation. Most of the irrigation works were undertaken before the population was ready to make adequate use of the water. Accordingly, they were not financially successful, and they have been relieved of most of their liabilities by the Irrigation and Water-Works Trusts Relief Act of 1899. The national works directly controlled by the Water Supply Office include a weir across the Goulburn River near Murchison, which forms a great storage reservoir for the floods, that would otherwise run to waste down the Goulburn in the winter. Another

national storage reservoir has been built at Waranga, which will be filled by the surplus overflow of the Goulburn, and will be used for the irrigation of the valleys of the Campaspe and the Loddon Rivers.

The Castlemaine and Bendigo goldfields are supplied by an artificial reservoir at Malmsbury. The flow of the Loddon River is controlled by three weirs, the largest of which forms the Laanecoorie Reservoir. It is, moreover, proposed to build a weir across the upper Murray below Jingellic, and transmit the water from this storage reservoir, across Northern Victoria, to the Mallee country. It is admitted that it would be impossible to irrigate the Mallee; but it is estimated that sufficient water could be conveyed there to supply the residents with water for household purposes, for watering stock, and probably for the irrigation of a garden of one acre in every four square miles of country. As the Mallee country has an average rainfall of 16 inches per year, it might possibly be more economical to utilise the local limestones for the formation of collecting surfaces, draining into storage tanks.

The Metropolitan Board of Works manages the Melbourne water supply, which is brought from the ranges in the Upper Yarra and the upper tributaries of the Goulburn.

12. Political Geography

The population of Victoria, as recorded by the census of April 1901, was 1,201,341, exclusive of 6814 Chinese and 588 aborigines; and the estimated population for 30th June 1904 was 1,206,098. Of the numbers recorded at the census of 1901, 603,883 were males and 597,458 females.

The government consists of a Governor appointed by the Crown, an Executive Council appointed by the Governor, and a Parliament of two Houses, both elected by the people. The Legislative Council consists of thirty-four members, who are each elected for a period of six years. One member of the Council represents the public service and the railways, the officers of which have no vote for the constituencies in which they reside. The second chamber consists of a Legislative Assembly composed of sixty-seven members, of whom sixty-four represent ordinary electorates, two represent the railway staff, and one the rest of the public service. The members of the Legislative Assembly receive £300 per annum each for expenses, as well as a free railway pass, which is also allowed to the members of the Council, who are otherwise unpaid. The electorate is practically universal manhood suffrage; but paupers are disqualified from voting for the Council, though they may vote for the Assembly. Voting is allowed by post; a man is only allowed to vote in one constituency. Women do not have votes for the State Parliament.

The revenue for 1904 was £7,313,591, of which £3,400,243 was received from the State railways. The total debt is £51,819,962, involving an annual charge of £2,159,050. The total value of exports for 1903 was £11,188,939, and of imports £12,339,615.

Considerable attention has been called recently to the decline in the Australian birth-rate, which when expressed in simple figures stating the number of births per 1000 of the population suggests alarming conclusions. The matter has been discussed by W. M'Lean, Government Statist of Victoria.[1] He explains the decline as due

[1] W. M'Lean, "The Declining Birth-Rate in Australia," *Intercolonial Medical Journal of Australia*, March 20, 1904. Melbourne, 1904.

to the fact that the people who came to Victoria during the period of state-aided emigration, and of the rush to the goldfields, were mostly young adults, and there was naturally a high birth-rate. The age distribution has now become more normal; while the low death-rate and the low infant mortality have reduced the relative proportion of those too young or too old to have children. M'Lean maintains that the natural increase of the population, *i.e.* the excess of births over deaths, in the Australian states is greater than in any of the European countries.

The emigration from Victoria during recent years has been largely due to Westralia having been mainly peopled by Victorians.

The Public Service of Victoria is under a Public Service Commissioner, who, in order to maintain the absolute independence of the service from political control, is independent of Parliament and amenable only to the Supreme Court of Justice.

The chief educational institution is the Melbourne University, founded in 1853. It is secular, but is associated with three colleges: Ormond, which is Presbyterian; Trinity, which is Church of England; and Queen's, which is Wesleyan. There is a Technical College for working men at Melbourne; there are Schools of Mines at Ballarat, Bairnsdale, and Bendigo. There are Grammar Schools, on sites granted by the State, at Melbourne and Geelong. Primary education is free, compulsory and secular. It is controlled by the Department of Education, under a Minister of Public Instruction and a Director of Education. Children are allowed free passage on the railway to their schools, and in the event of the school being far from their homes, they receive an allowance for conveyance by coach or

cab. The heavy cost of rural education is accepted as part of the land settlement policy, as people are not expected to settle where they cannot get education for their families.

The Public Library in Melbourne is probably the finest in the Southern Hemisphere.

The land laws of Victoria are explained in a digest issued periodically by the Lands Department of Victoria.[1] The regulations are perhaps more complex than in the other States, owing to the more detailed classification of the land in accordance with its very varied economic value. The Crown Lands are divided into various grades of agricultural and grazing land; land suitable for sheep and cattle runs; lands which have been reclaimed by public works; auriferous lands, of which the surface use can be obtained by license; and reserves for State forests, timber, and water-supply. The Crown Lands may be acquired by purchase at auction; on conditional purchase leases; by selection for residence or cultivation in small blocks on the mining fields; or by leases, which may be for a term of twenty-one years or in perpetuity. Land issued on grazing licenses, which are annual, give no rights below the surface or of sub-letting.

The Closer Settlement Bill of 1905 enables the Government compulsorily to repurchase estates which it thinks suitable for closer settlements. They are sub-let in small lots for farms or workmen's allotments, and sold under conditional purchase lease, the price, with interest at 4½ per cent, being repaid by half-yearly instalments. By this Act the Government is following the example set by private enterprise, in some of the

[1] Brown, A. G., *Digest of the Lands Acts, Victoria*, 2nd ed. Melbourne, 1901, pp. 45 and map.

large stations in south-western Victoria, which have been broken up into dairy farms.

13. Mining Law

The following summary of the Mining Laws has been kindly supplied by Mr. W. R. Anderson, the Secretary of Mines for Victoria. The Mining Laws were last revised by an Act of 1904.

OCCUPATION OF LAND FOR MINING.—Land may be occupied for mining purposes—gold or minerals—either by lease from the Crown, or under registrations made pursuant to bye-laws framed by the different Mining Boards for the seven mining districts of the State. Persons registering mining areas must hold miner's rights for each member of the party registering. A miner's right is an annual license issued by the Government, for which a fee of 2s. 6d. is charged.

Extent of Areas.—There is practically no limit to the area that may be held under gold-mining leases, the Minister having a very wide discretion, which is governed by the special facts of each case. Leases may issue for thousands of acres—the largest existing lease is for 5576 acres. Where land is taken up which is believed to contain deep, wet leads, the successful working of which must necessarily involve a large outlay, it is the practice to grant large areas if applied for, so that in the event of a payable lead being discovered the lessees may reckon upon having a reasonable extent of gutter; otherwise a lessee might find, after spending large sums and proving the existence of a good lead, that the portion within his lease was so small as to be of no practical value to him, although his neighbour, who had taken up the adjoining ground in the hope of benefiting by his

work, would reap a rich harvest. In quartz-mining the areas vary very greatly according to circumstances, a liberal allowance of ground being granted, if the expense of plant and working is likely to be heavy. The largest existing quartz-mining lease is for an area of 246 acres. Where small capital only is required, leases do not usually exceed 30 acres. The limit for mineral leases is 640 acres; but the spirit of the law is broken, as some of the coal companies hold several leases of 640 acres each, the leases being in the names of different persons who are really trustees for the companies behind them.

Land held under District Bye-laws.—Miner's-right holders are entitled to take up areas called "claims," subject to the conditions imposed by the bye-laws for the particular mining district in which the land marked out is situate. The areas of the claims vary according to the number of miner's-right holders in the party, so much ground being allowed for each holder. The possession of miner's rights, the registration of the claim with the Mining Registrar, and compliance with the labour and other conditions required by the bye-laws, are all that is necessary to confer a good title. The leasehold title, however, is preferred by investors, as it cannot be attacked, no matter how the lessee may fail to comply with the covenants—so long as the lease is not declared void by the Governor-in-Council. The miner's-right title is liable to be challenged at any time in the Warden's Court, and the claim lost through some trifling omission on the part of the holders.

Tenure of Mining Leases is dependent, in strictness, upon compliance with the covenants of the leases, the principal of which are the payment of rent and the employment of a certain number of men, or the expenditure of a certain amount of money each year. In practice,

the Minister never forfeits a lease if he believes that the holders are doing *bona-fide* work, although not complying with the requirements as to the employment of labour. Under the Act passed last session the Minister is empowered, in cases where he thinks the circumstances justify it, to provide for the expenditure of a certain sum per annum in plant, wages, etc., instead of stipulating for the employment of a certain number of men. This sum is fixed at an amount, stated in the lease, which the lessee might reasonably be expected to spend under the circumstances. For instance, in the case of mining for an alluvial lead, the expenditure for the first two years would be based upon what might be expected to be the outlay for that period, in boring operations to determine the trend of the lead; for the next two or three years the fair expenditure upon shaft sinking; subsequently that for putting in main drives and unwatering, say another three or four years. The full employment of labour would only be required when the operations were so advanced as to enable the wash to be taken out. This is a great advance upon the old system, which required the employment of a certain number of men, fixed according to the area of the lease, quite regardless of whether or not such a number could be advantageously employed. Under the old conditions a lease of say 1000 acres would require the employment of 36 men for the first six months, and 140 subsequently. Under the present law the expenditure would be fixed on the assumption that about 8 men should be employed while boring operations were being carried on, 12 men during sinking, and 16 men in the driving and unwatering stage of the mine.

Suspension of Labour and Employment Covenants.— The Minister has power to suspend the operation of

these covenants whenever the circumstances justify such a step. He cannot grant more than six months' suspension at any one time, but the suspension may be renewed from time to time. Under the new Act, a lessee has a statutory right to suspension (which, of course, the Minister cannot withhold) if he spends more money than is required by the covenants of his lease; *i.e.* he has the right to suspension for any excess expenditure, the period, up to two years' limit, depending on the amount of such excess.

Application for Forfeiture of Leases may be made by the holders of miner's rights, providing the lessee is not complying with the lease conditions, for periods not covered by suspensions. The Minister is not compelled to grant inquiries; he has a discretion in the matter. The applicant for forfeiture must under the new Act prove (*a*) that the lessee has not complied with the labour or expenditure covenant, as the case may be, and (*b*) that the applicant for the forfeiture, and his party, have the means and intend to work the lease.

Term.—Leases are issued for fifteen years, with the right of renewal to the lessee.

Rent and Royalty.—For Crown land gold-mining leases the rate is 2s. 6d. per acre, payable half-yearly; for private property 6d. an acre; for lands alienated from the Crown before 29th December 1884, 2s. 6d. an acre; for lands alienated after that date no royalty charges are made.

For mineral leases the minimum rental is 1s. per acre, which is the amount usually fixed.

Private Property.—Leases as claims for private property may be taken up in exactly the same manner as for Crown lands, with this qualification, that no right of entry for mining is given until either the consent of the owner and occupier is obtained or compensation has been

paid him; the amount of compensation may be fixed by the wardens for the goldfield, in the event of the applicant and the owner being unable to come to terms.

Reward Areas.—Any person holding a miner's right desiring to prospect in places where sinking in basalt is necessary, and at least five miles from gold workings, is entitled to mark off one square mile of ground, and if he discovers payable gold, has the right to a lease of 100 acres in any part of the square mile at a nominal rental (*vide* section 55 of the Miners Act 1890).

14. Towns in Victoria

ALBERTON (38° 37′ S. lat., 146° 40′ E. long.), on the Albert River, three miles above its mouth, in the county of Buln-Buln, in South Gippsland, 132 miles south-eastward by rail from Melbourne. The country to the northward is hilly, and clad with dense gum forests; the soil is good, and when cleared the ground is well adapted for farming and grazing. The town is rapidly growing, and it is the centre for a wide area to the northward, as it is near Port Albert on the coast. Population of the town, 500; of the district, 5600.

ARARAT (37° 30′ S. lat., 142° 57′ E. long., 1028 feet above sea-level), a railway junction on the line to Adelaide, where branch lines go to Portland, and across the southern district of the Pyrenees. It is 131 miles north-west of Melbourne. It is a mining centre for local quartz-mines, and the alluvial mines of the leads of the Hopkins Valley and of Mount William. The adjacent country is agricultural and pastoral, with numerous vineyards. The population of the town is 3580, and of the district, 8450.

BAIRNSDALE (37° 49′ S. lat., 147° 35′ E. long.), in the

county of Tanjil, is the leading commercial centre of Eastern Gippsland, being the chief port on the Gippsland Lakes, and the eastern terminus of the Victorian Railway system. It is a township on the Mitchell River, 171 miles east of Melbourne. The country along the Mitchell River is agricultural, hops and vines being important products. The land farther from the town is mainly pastoral, with mining at Cassilis, etc. Population of the town, 3000; of the shire, 8063; of the whole district, 15,000.

BALLAN (37° 36′ 19″ S. lat., 144° 13′ 37″ E. long.), on the Werribee River, 50 miles west of Melbourne, on the direct railway to Ballarat, is the centre of a rich pastoral and farming land on the eastern part of the Ballarat Plateau; some mines occur to the north. Population of the town is 450; of the shire, 6470.

BALLARAT (37° 33′ S. lat., 143° 52′ E. long., 1437 feet above sea-level) is the second city of Victoria, and historically the most famous mining town in Australia. It is on the Yarrowee Creek, 74 miles west-north-west of Melbourne. It consists of two municipalities—Ballarat East and Ballarat West. A monument on the site of the Eureka Stockade commemorates the battle between the miners and a military force on December 3, 1854, due to the protest of the miners against the conduct of the police in collecting the miners' license fees. Sturt Street, the main street of the town, and the Botanical Gardens, are adorned with good statuary. The city has a well-known School of Mines. It is the centre of six branch railways. The population of Ballarat is 25,448; of Ballarat East, 18,262.

BEECHWORTH (36° 22′ S. lat., 146° 41′ E. long., 1805 feet above sea-level), the chief town in north-eastern Victoria, in the county of Bogong. It is 172 miles by

rail north-eastward from Melbourne. It is on a branch railway, which leaves the main line at Wangaratta, 22 miles to the west. It is on Spring Creek, and was the centre of the famous Ovens Goldfield. The main industry of the district is mining, but agriculture and fruit-growing are carried on, and it is a good educational centre. Population of the town is 3000; of the district, 8000.

Benalla (36° 33′ S. lat., 145° 59′ E. long., 558 feet above sea-level), on the Broken River, 121 miles north-east of Melbourne. It is the centre of an important agricultural and pastoral district, the produce being wheat, oats, hay, and vines. Some unimportant gold-mines and some veins of turquoise occur in the hills to the south. The population of the town is 3000; of the district, 8750.

Bendigo (36° 46′ S. lat., 144° 17′ E. long., 758 feet above sea level), the third city, and at present the most important mining town in Victoria. It is in the county of Bendigo, on Bendigo Creek, on the main railway line from Melbourne, 101 miles north-north-west of Melbourne. It is an important railway centre, and the main line continues 56 miles northward to Echuca, the leading port on the Upper Murray. Bendigo is situated in a valley traversing a belt of folded Ordovician rocks, in which occur many auriferous veins; they follow the folding of the surrounding rocks, and thus form the saddle reefs for which this field is famous. By following the axial lines of the folds, the successive saddle reefs have been traced downward to the depth of over 4250 feet, and they include at present the deepest developed gold-mines in the world. The township of Eaglehawk, four miles to the north, is practically a suburb of Bendigo, and includes some of the richest mines. The opening of the district in 1851 was due to the discovery of rich alluvial deposits of gold.

Many explanations of the name have been offered, but it was probably derived from a notorious prize-fighter; for some years the name was officially altered to Sandhurst. Population, 31,020.

BERWICK (38° 1′ S. lat., 145° 21′ E. long., 165 feet above sea-level), in the county of Mornington, on Cardinia Creek, 27 miles south-eastward from Melbourne. There are numerous dairy-farms in the district; also many large gardens and orchards. The crops grown are oats, peas and beans, potatoes, artificial grasses, and hay. The great Cranbourne meteorite was found in this district. Population of the town, 636; of the district, 6500.

BRIGHT (36° 44′ S. lat., 146° 58′ E. long.), the chief town in the Australian Alps. It is the terminus of the branch railway from Wangaratta. It is on the Ovens River. A coach road, closed in the winter by snow, crosses the Alps to Omeo. It is the most convenient centre for ascents of the chief summits in the Victorian Alps, Mount Bogong, Mount Feathertop, and Mount Buffalo. The chief industry is gold-mining, both quartz and alluvial—much of the present alluvial yield being obtained by dredges in the Ovens River. Population of the town, 900; of the district, 5600.

CAMPERDOWN (38° 15′ S. lat., 143° 9′ E. long.), the chief town in the county of Hampden, and of the rich Western Plains of Victoria. It lies at the foot of Mount Leura, a well-preserved extinct volcano on the main road from Geelong to Warrambool, 123 miles west-south-west of Melbourne, and 78 miles west of Geelong. It is the market-town for the great sheep stations on the plains to the north; and near the town the stations are being broken up into dairy-farms. The soil of the district is very fertile. Population of the town, 2000; of the district, 6090.

Castlemaine (37° 4′ S. lat., 144° 14′ E. long., 919 feet above sea-level), in the county of Talbot, in a basin at the southern foot of the Mount Alexander Range. It is at the junction of Barker's and Forest Creeks, 78 miles by rail north-north-west of Melbourne. It is on the railway to Bendigo, and branch lines start from it to Maldon and Maryborough. The gold-diggings here were first known as Forest Creek, or the Mount Alexander diggings; and in the first year of the gold-mining in Victoria they were the most important. A grey "granite" is quarried at Harcourt, in the hills to the north of the town. Population of the town is 5704.

Colac (38° 31′ S. lat., 143° 36′ E. long., 436 feet above sea-level), beside Lake Colac in the county of Polwarth, 95 miles south-westward of Melbourne, on the Barongarook Creek. It is the market-town for a rich agricultural district on the southern border of the Western Plains of Victoria. The old sheep stations are now being subdivided into dairy-farms. Large crops are grown of wheat, oats, barley, hay, and potatoes. The population of the town is 2817; of the district, 10,200.

Creswick (37° 25′ S. lat., 143° 54′ E. long., 1438 feet above sea-level), on Tullaroop Creek in the county of Talbot, 85 miles north-westward of Melbourne, and 11 miles northward of Ballarat, is an important gold-mining centre. The diggings were discovered in 1852. The most important mines are near Smeaton on the "deep leads," bands of river gravel now buried beneath sheets of basalt that were poured from extinct volcanoes. The most famous of the mines is the Madame Berry, now worked out. The decomposed volcanic rocks of the area yield rich soils. The population of the town is 3060; of the shire, 7177.

Dunolly (36° 52′ S. lat., 143° 44′ E. long., alt.

631 feet) is a mining township in the southern end of the Pyrenees.

ECHUCA (36° 8′ S. lat., 144° 46′ E. long., 320 feet above sea-level), in the counties of Rodney and Gunbower, is at the confluence of the Murray and Campaspe Rivers, 156 miles northward from Melbourne. It is the chief port on the Upper Murray. The river is crossed by a joint road and railway bridge to Moama in New South Wales. The railway continues northward to its terminus at Deniliquin. The district is agricultural, with extensive vineyards. Population of the town, 3970; of the district, 4192.

EUROA (36° 45′ S. lat., 145° 34′ E. long., 574 feet above sea-level), in the counties of Moira and Delatite, is on the Seven Creeks, 94 miles north-eastward of Melbourne, on the main Melbourne-Sydney Road. The district is agricultural and pastoral, with many dairy-farms. Population of town, 1250; of the district, 5444.

GEELONG (38° 10′ S. lat., 144° 21′ 17″ E. long.) is the second port in Victoria, as it is the outlet for the wool and wheat raised of the Western Plains. It is in the county of Grant, on Corio Bay, the long western arm of Port Phillip. It is 45 miles south-westward of Melbourne. It was founded shortly after Melbourne, and until the discovery of the goldfields was the second city in Victoria. The first woollen mill in Victoria was established here. The surrounding country is mainly agricultural, but there are some woollen mills, and large lime works at Fyans Ford. The population of the town and suburbs is 23,311.

HORSHAM (36° 45′ S. lat., 142° 15′ E. long.), in the county of Borung, on the right bank of the Wimmera River, is the chief business centre in the Wimmera district. It is 203½ miles west-north-west of Melbourne, on the main line to Adelaide. The district is

principally agricultural, and an extensive scheme of irrigation is being developed for water stored in artificial reservoirs. Population of the town, 2717; of the district, 9000.

JUMBUNNA. *See* Korumburra.

KOROIT (38° 17′ S. lat., 142° 24′ E. long.), in the county of Villiers, between Warrnambool and Port Fairy, is an agricultural district, and has an exceptionally rich soil. It is on the northern slope of Tower Hill, a well-preserved volcano, of which the latest cone and crater are on an island in a lake, on the floor of a volcanic caldron. Population of town, 1683; of district, 6000.

KORUMBURRA (38° 30′ S. lat., 145° 50′ E. long.), in the county of Buln-Buln, is the chief town in the Victorian coal-fields. It is 69 miles south-south-east of Melbourne, on Coal Creek. It is the railway junction for the branch line to Jumbunna and Outtrim. The adjacent hills are densely timbered but they are being rapidly cleared; the ground then affords fine pasture, and the area is becoming an important dairying country. The nearest coal-mine is that at Coal Creek, a mile to the south-eastward of the town. The chief coal-mines are at Outtrim and Jumbunna. Population of the town, 4000; of the district, 6500.

KYNETON (37° 12′ S. lat., 144° 27′ E. long., 1687 feet above sea-level), in the county of Dalhousie, on the Campaspe River, 57 miles north-westward of Melbourne. It is an important agricultural town, near the pass through which the railway and road to Sydney cross the main divide. Population of town, 3371; of the district, 9500.

LILLYDALE (37° 40′ S. lat., 145° 21′ E. long.), in the county of Evelyn, on Olinda Creek, 24 miles north-east of Melbourne. It is a rich agricultural district, with extensive vineyards and orchards. A bed of Silurian

limestone is quarried and burnt for lime. The population of the town is 1000; of the shire, 5364.

HOUSES OF PARLIAMENT, MELBOURNE, NOW OCCUPIED BY THE COMMONWEALTH PARLIAMENT.

MALDON (37° S. lat., 144° 5′ E. long.), a mining township in the county of Talbot, at the foot of Mount

Tarrangower, on the Tarrangower Creek. It includes some famous gold-quartz mines, of which the most famous is the South German Mine. Some important mines, on the "deep leads" of the Loddon Valley, occur in the plains to the westward. Population of the town, 2800; of the district, 5800.

MARYBOROUGH (37° 3′ S. lat., 143° 44′ E. long.), in the county of Talbot, 112 miles north-westward of Melbourne, is an agricultural, mining, and railway centre. Population of shire, 3451; district, 15,000.

MELBOURNE (37° 49′ 53″ S. lat., 144° 58′ 42″ E. long.) is the metropolis and seat of government of Victoria, and the temporary capital of the Australian Commonwealth. The city is named after Lord Melbourne, who was Premier of Great Britain when it was founded in 1836. It is a well-built city, with broad, regularly arranged streets, many fine public buildings, a Public Library, Museum, and famous Observatory. The library is probably the best in the southern hemisphere. The University is one of the two chief educational institutions in Australia. The city is very healthy, and has a fine water-supply brought from the hills to the north and north-eastward. It is a great port, and its manufactures are making rapid progress; but its chief importance is as a great administrative centre. Vessels go up the Yarra River[1] to the centre of the city, but the large mail-steamers berth at Hobson's Bay, 3 miles to the south.

[1] The origin of the name "Yarra" has been frequently discussed. Wedge in a letter, which is now in the Public Library in Sydney, wrote to Gurner on 10th March 1871, "I named the river 'Yarra Yarra' from the circumstance of the native boy, on our coming in sight of it, calling and pointing towards it 'Yarra Yarra,' from which I inferred at the time that it was the natives' name of the river, but I learnt afterwards, on recrossing the Werribee, near a small fall in the river, that it was the native appellation for a water-fall."

The population of Melbourne, including the suburbs, is 493,956.

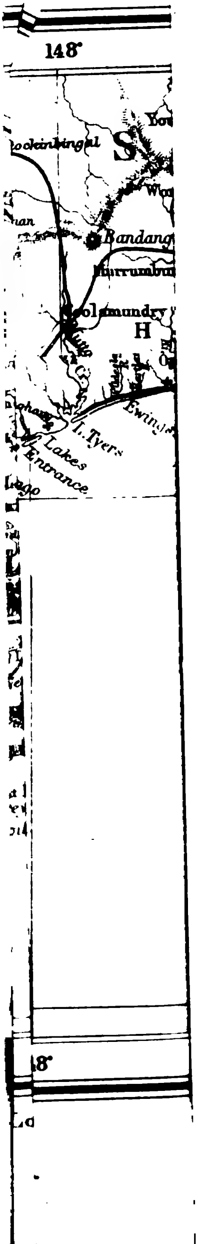
OMEO (37° 6′ S. lat., 147° 40′ E. long., 2100 feet above sea-level), in the county of Benambra, 250 miles east-north-east of Melbourne, on Livingstone Creek. It is the chief town in the mountains of eastern Gippsland, and is historically famous, as it was settled by colonists from New South Wales, who, continuing southward, were the first to reach Gippsland. It is situated 80 miles north of Bairnsdale, on a coach road, across eastern Victoria to Glen Wills and the Mitta Valley. Numerous gold-mines occur in the mountains of the district. Population of the district is 5700; of the town, 900.

OUTTRIM. *See* Korumburra.

PORTLAND (38° 21′ 30″ S. lat., 141° 41′ E. long., 40 feet above sea-level), a seaport in the county of Normanby, on Portland Bay, 225 miles south-westward of Melbourne. It was the first definite settlement established in Victoria, as it was founded as a whaling station by the Hentys in 1834. The district is agricultural. The population of the town is 2146; of the district, 5624.

RUSHWORTH (56° 36′ S. lat., 144° 47′ E. long.), in the county of Rodney, 104 miles north-eastward from Melbourne, was once an important mining centre. The mines are now of less importance than the agricultural industries of the district. A great reservoir is being constructed at Waranga for the irrigation of the plains to the north. Population of town, 1000; of district, 5890.

SHEPPARTON (36° 22′ 30″ S. lat., 145° 24′ E. long.), in the county of Moira, 113 miles north-north-east of Melbourne, on the Goulburn River, is the leading township in the fertile plains of the Lower Goulburn, the value of which is being increased by extensive irrigation works. Population of town, 3200; of district, 5300.



148°
S
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Lakes
Entrance

Saint Arnaud (36° 37′ S. lat., 143° 16′ E. long., alt. 784 feet) is the chief mining town at the northern end of the district known as the Pyrenees. The most important mine is the Lord Nelson.

Stawell (37° 3′ S. lat., 142° 47′ E. long., 759 feet above sea-level), in the county of Borung, 150 miles north-west of Melbourne, is the gold-mining centre, formerly known as Pleasant Creek. It has important deep gold quartz-mines. The population of the shire is 3552; of the borough, 5296.

Swan Hill (35° 20′ S. lat., 143° 35′ E. long.), in the county of Tatchera, is the second important Victorian port on the river Murray. It is 214 miles north-north-west of Melbourne, at the terminus of a railway line through Bendigo and Kerang. The district is agricultural and pastoral. Population of town, 950; of district, 5500.

Tallangatta (36° 12′ S. lat., 147° 15′ E. long.), in the county of Benambra, at the junction of the Tallangatta Creek and the river Mitta Mitta. It is 212 miles north-eastward of Melbourne. It is the terminus of the railway, and is the market-town for a wide district in north-eastern Victoria, which is occupied for mining (gold and some tin), and pastoral industries. Population of town, 600; of shire, 6800.

Warrnambool (38° 24′ 17″ S. lat., 142° 28′ 26″ E. long.), in the county of Villiers, on the shore of Warrnambool Bay, 166 miles south-westward from Melbourne. It is the chief port of Western Victoria, as it has a good harbour, rich agricultural land behind it, and easy roads northward into the plains of Western Victoria. It was shaken in 1903 by two earthquake shocks of some severity. The town stands on hills of dune limestone, worked as a building stone. Population of the town, 6410; of the district, 9089.

WEDDERBURN (36° 25′ S. lat., 143° 37′ E. long., 657 feet above sea-level), in the county of Gladstone, stands on Korong Creek, 151 miles north-north-west of Melbourne. It is a small mining town at the northern end of the line of auriferous quartz reefs, which runs from Dunolly through Moliagul and Rheola. It is a good farming district. Population of the town is 1400; of the district, 7500.

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CHAPTER XIV

TASMANIA

TASMANIA is the smallest State in the Australian Federation. It is an island to the south of Victoria, from which it is separated by Bass Strait. It extends from the latitude of 40° 33′ S. to 43° 39′ S., and from the longitude of 144° 39′ E. to 148° 23′ E. The island is somewhat heart-shaped, and it is especially irregular and jagged to the south, owing, no doubt, to the subsidence of the country having enabled the sea to drown some of the old river valleys.

The area is 26,215 square miles. It is bounded by Bass Strait in the north, and on the other sides by the Southern Ocean. The whole island is very mountainous. It has been described as a continuation of the Eastern Cordillera of Australia, which was thought to cross the Great Valley of Victoria along the Divide at the head of the Latrobe River, near Drouin; and to continue across Wilson's Promontory and along the chain of islands that run south-eastward across the Strait, into Tasmania.

1. History

Tasmania was discovered by Abel Tasman in 1642, and called by him Van Diemen's Land, a name officially

altered to Tasmania in 1856. The island was visited by du Fresne in 1772, and Cook in 1777, and d'Entrecasteaux in 1792-93. It was proved to be an island, as suspected by Cook, by Bass in 1797, and was first circumnavigated by Flinders and Bass in 1798. It was annexed to the British Empire by the *Glatton* in 1803, and used as a convict station, the first settlement being at Risdon. The settlement was moved to Hobart in 1804, on the arrival of Collins, who remained the commandant till his sudden and suspicious death in 1810.

Settlements from Sydney were established on the northern coast, of which the chief was Launceston, founded in 1807. A terrible famine afflicted the island from 1807 to 1809; quarrels with the aborigines resulted in a war, which lasted until, in 1832, a private settler, Robinson, induced them to surrender. They were removed to an aboriginal reserve on Flinders Island. In 1825 Tasmania was separated from New South Wales as an independent colony, and the import of convicts ceased in 1853. A Constitutional Government was granted in 1855.

The white population grew but slowly. In 1818 it was only 3240, all grouped around Hobart on the southern coast and Launceston on the northern. The population had grown by 1841 to 57,420, which increased to 90,211 in 1861, and to 115,705 in 1881; in the census of 1901 it was returned as 172,475, and was calculated on the 31st December 1903 as 179,487.

The geography of southern Tasmania was early explored from Hobart and the northern district from Launceston; but the western coast, though the part first seen by Tasman in 1642, long remained but little known. Flinders in 1798 described most of the chief headlands, and Macquarie Harbour was discovered by Kelly in

1816. It was not until the establishment of a convict settlement in 1822 on Sarah or Settlement Island, in Macquarie Harbour, that much information about the western country was discovered. Some of the convicts escaped from Macquarie Harbour, only in most cases to perish in the forests; comparatively few were able to find their way across the intricate, western highlands to the settled districts around Hobart. The first survey of the country behind the western coast was by Calder between 1840 and 1842. Sir John Franklin, in 1842, crossed overland from Macquarie Harbour to Hobart, and his journey was accompanied by characteristic misfortunes. The first extensive contribution to the geography of this part of Tasmania we owe to Gould in 1860 and 1863. He traversed the Linda valley, the present site of Mount Lyell, and, recognising its glacial deposits, called it "Chamounix Valley." He named the West Coast Range, and christened its chief peaks Mount Murchison, Mount Sedgwick, Mount Lyell, and Mount Owen. The chief valleys were opened up by woodmen felling Huon pine and other valuable timber; the mountains were searched by miners and prospectors, and the tracks were cut and the land roughly mapped by T. B. Moore.

A great stimulus to the development of western Tasmania was given by the discovery of tin at Mount Bischoff in 1871, and by Sprent at Heemskirk in 1875, and of the silver-lead ores at Zeehan in 1884. In 1881 Conrad Lynch began prospecting in the southern part of the West Coast Range from Macquarie Harbour; and in November 1883 Karlson and the two M'Donough brothers, directed to the Linda Valley by T. B. Moore (the chief pioneer after Gould in this part of Tasmania), discovered the Mount Lyell Mine. Its active develop-

ment dates from 1891, and the railway from the King River to the mining field at Queenstown was opened in July 1896.

2. Geographical Structure

The island may be regarded as a horst—a block of ground standing as a mass of isolated highland, owing to the subsidence of the surrounding earth-blocks. In structure it is a plateau, which attains, in the centre, the height of 3500 feet; but the surface has been so denuded by river action, that the traces of the plateau surface are recognisable only on a broad general view. Here and there broad, high plains remain as fragments of the original plateau. The plateau faces the west, the north, and the east in steep scarps, which are locally named by the expressive name of Tiers, such as Bonney Tier, and also as Bluffs, such as Dry's Bluff. The Central Plateau extends from Dry's Bluff (4257 feet) on the north, for 50 miles to Cradle Mountain (5069 feet) on the north-west; and from Dry's Bluff for 60 miles south-westward to the Denison Range, and 43 miles southward to Table Mountain. The "Great Western Mountains," which rise abruptly from the lowlands of the Launceston basin, are the north-eastern edge of the plateau. Ben Lomond (5010 feet), the chief point in north-eastern Tasmania, is an outlier of it, and Mount Wellington (4166 feet) is the prominent bluff on the southernmost edge, where it overhangs Hobart. The chief summits in Tasmania, including the highest, Cradle Mountain (5069 feet), are elevations on the Central Plateau.

At the foot of the Tiers which bound the Central Plateau are a series of lower plains, which have been shown to be fragments of peneplanes. The Middlesex,

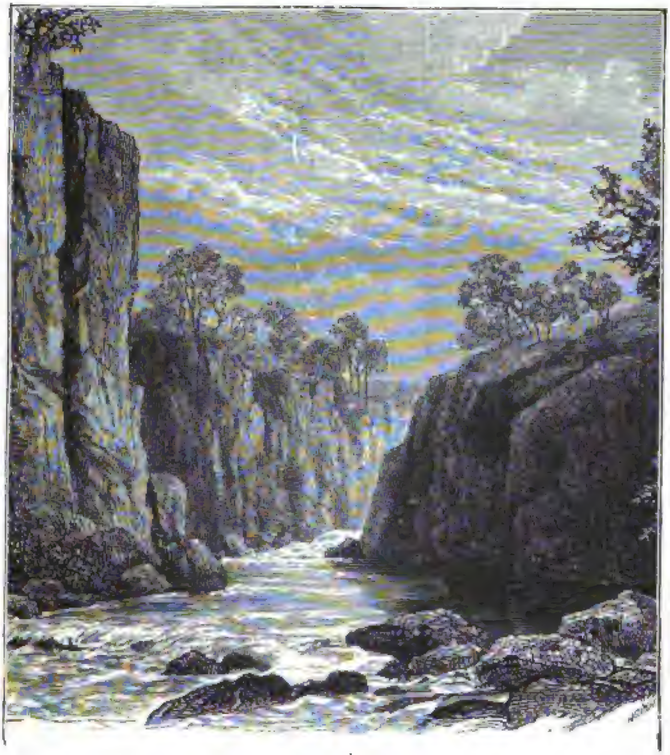
Hampshire, and Emu Plains are some of the best developed. Some of the high peaks, such as Mount Bischoff, Mount Heemskirk, and Mount Zeehan, rise abruptly above the general level of this peneplane surface.

The "West Coast Range" of Tasmania also rises above the north-western peneplanes: it consists of a chain

MOUNT WELLINGTON.

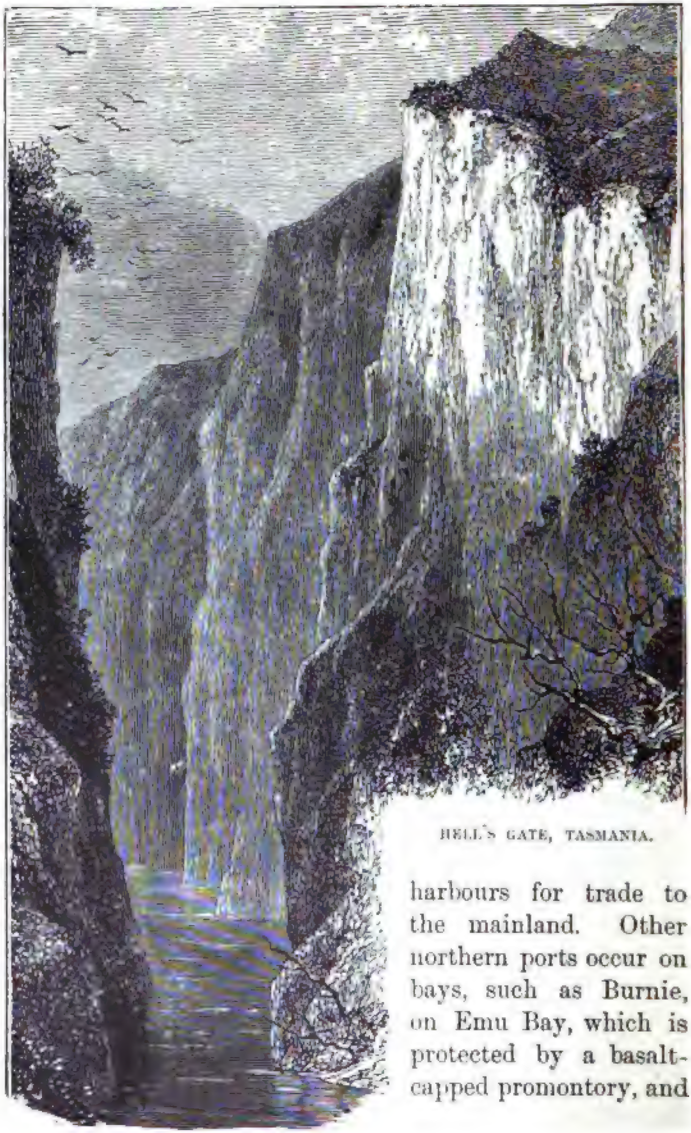
of isolated hills of Devonian conglomerates, extending from Mount Black on the north, through Mount Murchison, Mount Read, Mount Tyndall, Mount Geikie, Mount Sedgwick, Mount Lyell, Mount Owen, Mount Huxley, and Mount Jukes, to Mount Sorell above Macquarie Harbour. The Dial Range, near Burnie, is of similar structure, and represents a former, northern continuation of the West Coast Range.

The lakes of Tasmania lie upon the Central Plateau. The largest, Great Lake, is 90 miles in circumference. The other chief lakes are Lake Sorell, Lake Echo, and Lake St. Clair.



ON THE SOUTH ESK, A TRIBUTARY OF THE TAMAR RIVER, TASMANIA.

The chief rivers flow northward into Bass Strait, or southward into the great southern estuaries. Those which enter Bass Strait, like the Tamar, the Mersey, and the Forth, have large estuaries, which form important



HELL'S GATE, TASMANIA.

harbours for trade to the mainland. Other northern ports occur on bays, such as Burnie, on Emu Bay, which is protected by a basalt-capped promontory, and

Stanley, which is sheltered by the long peninsula of Circular Head. The rivers on the west coast, such as the King River, show the geographical youth of the country by flowing through canyons which they have cut through the plateau; these deep clefts, such as Hell's Gate (p. 458), are great obstacles to internal communication. The chief arm of the sea on the western coast is Macquarie Harbour, into which flow the Gordon River and the King River. The great inland basin of Macquarie Harbour has a narrow and sometimes difficult entrance. On the southern, and especially on the south-eastern coast, the land projects to the sea in a long series of peninsulas, such as Port Davey, the Tasman Peninsula, and the Forestier's Peninsula; while Bruni Island, which was once a similar peninsula, has been separated as an island by the d'Entrecasteaux Channel. The Tasman Peninsula is now linked to the mainland only by the narrow, historic Eaglehawk Neck.

The considerable elevation of Tasmania, and its position in the full front of the west winds of the "roaring forties," give it a wet climate. Its rivers have an enormous discharge in comparison to their length. The annual rainfall in the Hobart district is an average of from 25 to 30 inches; but on the highlands of the north-western coast the average is over 60 inches. It rises in many places to over 100 inches, and the rain gauge at Lake Margaret, near Mount Lyell, has recorded over 140 inches a year. Accordingly the mountains are clad in dense forests, which, combined with the rugged nature of the country, has greatly delayed the settlement and progress of Tasmania as well as its scientific exploration.

3. The Geology of Tasmania

Geographically and geologically Tasmania is an outlier of south-eastern Australia, and its geology is intimately connected with that of Victoria. A detailed account of the geology of the island is given in Mr. R. M. Johnston's

Photo. *A. E. Kitson.*

EAGLEHAWK NECK, BY WHICH TASMAN PENINSULA IS CONNECTED WITH THE MAINLAND OF TASMANIA.

comprehensive work, *The Geology of Tasmania*; and a sketch bringing the subject up to date has been written by W. H. Twelvetrees, the Government Geologist, in his *Geology of Tasmania* (17 pp. 1901).

The Central Plateau of Tasmania consists of a sheet of Mesozoic dolerite, resting on a worn block of Palæozoic

rocks, which rest on a foundation of Archean rocks. The Archean rocks are not very extensively exposed. The quartzites of Port Davey have been described as pre-Cambrian, but this age appears to be only a matter of tradition. The gneisses and schists of the Dove River and the Upper Forth, and the hornblende schists of the Whyte River, are doubtless Archean; the Mount Lyell schists, which underlie the West Coast Range in the mining-field of Mount Lyell, are either Archean or Lower Palæozoic. The pre-Cambrian rocks are covered by a broad series of Lower Palæozoic deposits, which outcrop from beneath the Central Plateau and form the whole of the lower country in western and northern Tasmania. Lower Palæozoic rocks occupy the whole country from Cape South West along all the western and northern coasts, and down the eastern coast to the mouth of the Piccanninny River, near St. Mary's. They are sometimes covered by later deposits, as in the Launceston basin. The Devonian conglomerates include jasperoid pebbles, like those of the Heathcotian series in Victoria, so that series may also be represented in Tasmania. The Lower Palæozoic rocks begin with an interesting series of Cambrian sandstones, found in Northern Tasmania, near Latrobe. They strike to E. 60 S., and contain a series of typical Cambrian fossils, including—*Dikelocephalus tasmanicus*, R. Etheridge, jun.; *Conocephalites stephensi*, R. Etheridge, jun.

The Ordovician rocks are not yet certainly known. They appear to be very widely distributed in Western Tasmania, and to include the limestones of the Gordon River, and an extensive series of slates and sandstones in the upper part of the Henty River, near Mount Lyell, and in the mining field of Beaconsfield and Lefroy, near the estuary of the Tamar River.

The Silurian rocks are represented by slates, lime-

stones, and brachiopod sandstones, as at Zeehan, Heazlewood, and the Queen River. The limestones at Zeehan have yielded a series of fossils which have been described by Mr. R. Etheridge, jun., and there can be no doubt of their Silurian age, as they have yielded the following fossils—*Hausmannia meridiana, Illænus johnstoni, Cromus murchisoni, Rhynchonella borealis.*

The Silurian rocks have a trend slightly to the west of north, and they are highly faulted. They form the hill of Mount Bischoff, where they have been intruded by the series of porphyrite dykes of the famous tin-mine.

The Devonian system contains some shales, which are doubtfully referred to it; and its most important members are the rocks of the Dial Range and the West Coast Range. They are massive quartzites and coarse conglomerates, outliers of which form the peaks of the West Coast Range, as at Mount Lyell and Mount Owen. The conglomerates have there been thrown against the Mount Lyell schists and felsites by a series of long, north and south faults, overthrust to the west, which traverse the Mount Lyell field. Its famous ore deposits occur in close association with the faults.

A great series of granitic rocks, similar to those largely developed in Victoria, were intruded in Devonian times. They have considerably altered the older beds, as around Mount Heemskirk. The quartz porphyrite dykes of Mount Bischoff were probably intruded in this period.

The rest of the Upper Palæozoic rocks of Tasmania belong to the Permo-Carboniferous. The lower series are of marine origin, and include mudstones, limestones, conglomerates, and grits. The limestones contain abundant Carboniferous fossils, such as *Favosites, Spirifera, Productus, Conularia, Pachydomus, Motomya, Aviculopecten,* etc.

The Carboniferous rocks occupy the south-eastern quarter of Tasmania, meeting the Lower Palæozoic at South Cape on the west, and the Piccanninny River on the north. An outlier of this formation on the northern coast forms the Mersey Coal-field; and an outcrop of it runs in a zone all around the edge of the Central Plateau, and its outliers, such as Ben Lomond, and of the plateau to the west of Franklin. The Carboniferous rocks occur along the valley of the Derwent, forming Bruni Island and Maria Island, where the limestones have been worked for lime. The limestones are interbedded in a series

Photo. *J. W. Gregory.*

MOUNT OWEN, FROM THE MOUNT LYELL MINE.

The slopes bounding the Linda valley are glaciated, and Gormanston, the town below Mount Owen, stands on a glacial moraine.

of mudstones containing brachiopods. The "tesselated pavement" of Eaglehawk Neck is a bed of mudstone, which has been given a prismatic jointed structure, owing, according to Twelvetrees, to a concealed sheet of intrusive igneous rock.

The Upper Carboniferous series includes shales containing the mineral known as Tasmanite, which is contained in beds of variously coloured clays, with thin layers of bituminous shale. These beds are followed by the coal series of the Mersey basin, to the east of Launceston; it contains beds of grits and shales, with the characteristic fossils, including—*Gangamopteris cyclopteroides*, Feistm., and *Glossopteris browniana*, Brongn.; *Nœggerathiopsis hislopi*, Bunb.

Unfortunately for Tasmania, though the coal is good, the seams are thin, and the mines have not yet been very extensively developed. These coal seams are covered by marine beds, containing *Fenestella plebeia*, *Spirifera tasmaniensis*, etc. The coal-measures also occur on the Henty River on the western coast, and are covered by mudstones and impure limestones, containing *Fenestella plebeia*, *F. internata*, *Protoretepora ampla*, *Stenopora tasmaniensis*. The marine Permo-Carboniferous rocks also occur to the east of the West Coast Range, in the upper part of the basin of the King River. An outlier at Wynyard on the northern coast, which is on the horizon of the Greta Coal-measures of New South Wales, has been shown by Kitson to be associated with boulder beds of glacial origin. Hence Tasmania participated in the Upper Palæozoic glaciation of Victoria and New South Wales.

The Carboniferous rocks of Port Cygnet, south of Hobart, have been invaded by an interesting series of igneous rocks, which have been described by Mr. Twelve-

trees. They include tinguaites and sölvsbergites, and other igneous rocks formed of minerals, rich in soda.

Above the marine Upper Palæozoic beds are a series of fresh-water deposits containing *Vertebraria australis* and the remains of fishes and *Labyrinthodonts*, with such fossils as *Acrolepis hamiltoni*, etc. These beds are assigned by Twelvetrees to the Mesozoic; but if the Vertebraria be correctly identified, they should be Palæozoic. They are covered by sandstones and shales containing some coal seams, which occur at Ida Bay. These fresh-water beds flank the rocks of the Central, Western, and Eastern Tiers. Their fossils, such as *Pecopteris lunensis*, probably indicate their Triassic age. Then follows a series of sheets and intrusive masses of diabase and dolerite, which appear to have been formed as laccolites and sills. They cover large tracts of the Central Plateau of Tasmania, and their abrupt edges form many of the most prominent tiers: western outliers of the dolerite form the Eldon Range and the peak of Mount Sedgwick; to the south, they form Mount Wellington, near Hobart. The age of this igneous series has been regarded as Carboniferous; but it is placed by Twelvetrees as Mesozoic, and probably Cretaceous.

The Cainozoic rocks consist of two main groups. Tasmania contains but few of the marine beds, which are well developed in Victoria. The most important exposure occurs at Table Cape, which has yielded an abundant fauna of Mollusca, and the primitive marsupial Wynyardia, described by Spencer. The age appears to be Oligocene, or Miocene.

The second group of the Lower Cainozoic rocks are clays and sands deposited in river valleys and lakes, and preserved, in many places, beneath sheets of basalt. These beds are well developed in the valley of the

Tamar around Launceston. They contain many fossil plants, which appear to be of the same age as those beneath the older basalts of Victoria. Many of them were referred to European genera, but the identifications are not now accepted. The basalts of this period project as promontories along the northern coast,

Photo. *A. E. Kitson.*

THE OLIGOCENE (OR MIOCENE) BEDS AT TABLE CAPE, TASMANIA.

as at Burnie and Circular Head; and they form the rich soil of the Hampton Plains to the south of Burnie. A series of limburgite dykes were injected at this time. Some of the basalts contain nepheline, as at Circular Head and Table Cape. The Upper Cainozoic rocks include drifts which are often economically important, as they contain tin and gold.

Late in Cainozoic times, doubtless in the Pleistocene, north-western Tasmania was a glacial centre. The hills

Photo. A. E. Kitson.

COLUMNAR BASALT, BURNIE, TASMANIA.

of the West Coast Range, of the Eldon Range, and Mount Ida, were covered with glaciers which discharged westward into the valley of the King River, the Macintosh River, and the Henty. The lowest moraines occur at a height of about 400 feet above sea-level. The glaciation was first discovered by Charles Gould, in the Cuvier Valley, and asserted in his report of 1860;[1] but though repeatedly denied, the high-level glaciation was established by Dunn and Moore. A later account, with descriptions of recent low-level glacial deposits, has been given by the author,[2] who showed that, in the same district, there are two sets of glacial deposits, some of Carboniferous, and some of Pleistocene age; their association introduced the difficulties which had thrown doubt upon the recent existence of glaciers in Tasmania.

4. Political Geography

The Government of Tasmania consists of a Governor appointed by the Crown, an Executive Council, and a Ministry of five members, of whom the Premier receives a salary of £200 per annum. The Parliament is of two houses. The Legislative Council of eighteen members is elected by a somewhat restricted body of electors, who have either property or professional qualifications. The Legislative Assembly consists of thirty-five members, who are allowed £100 a year each, if they make the required number of attendances. The members of the Assembly are elected by adult suffrage. The administration is conducted by the Departments of the Chief Secretary and Treasurer, and of Mines, Lands, Agriculture, and Police.

[1] "A Report of the Exploration of the Western Country," by C. Gould, *Parl. Pap. Tasmania*, 1860, No. 6, 18 pp.

[2] *Quart. Journ. Geol. Soc.*, vol. lx. 1904, pp. 37-53; pl. vii.-viii. This paper contains references to former literature.

The population of the State was 172,475, or 6·58 per square mile, at the census of March 1901. The revenue for the year 1903 was £857,667. The expenditure was £879,219. The State Debt on December 31, 1903, was £9,318,400. The value of the imports in 1903 was £2,593,810, and the exports £2,843,108. The exports in 1902 were £3,244,508, including—

Copper and copper ores	£710,146
Lead and silver ore	387,024
Tin	237,846
Gold	172,928
Wool	263,521
Potatoes	325,034
Fruit (mainly apples)	272,789
Jam	111,339

Hence the mineral wealth of the island is its most valuable product. Copper is the most important metal. Nearly all of it comes from the Mount Lyell mines.[1] The output for 1903 was 6606 tons, and the ingots exported contained 660,091 oz. of silver and 21,478 oz. of gold.

The Mount Lyell Mines occur, in the West Coast Range, in the Linda Valley, a tributary of the King River. The two chief mines are near the towns of Gormanston and North Lyell. The ores from both are smelted at Queenstown, at the head of the railway from Strahan, a port on Macquarie Harbour.

The lead and silver come from mines in the Silurian rocks, most of which occur near Zeehan. The tin is mostly from the great mine at Mount Bischoff.

Coal is worked to some extent, the chief collieries being at Cornwall and Nicholas. Iron ores of good quality occur in large masses at various localities, notably

[1] An account of the field is given by the author, *The Mount Lyell Mining Field, Tasmania.* Melbourne, 1904.

on the Blythe River, near Burnie; but the projected iron-smelting industry has been delayed by the uncertainty as to proposed Commonwealth legislation upon the subject.

5. The Mining Laws of Tasmania

The following summary of the mining laws has been kindly supplied by Mr. W. H. Twelvetrees, the Government geologist:[1]—

The mineral lands of the State are dealt with by the Department of Mines. The Department is controlled by the Minister of Mines, and its permanent head is the Secretary for Mines.

Under the Mining Act the following licences and leases are issued:—

(1) Prospectors' licences and leases are granted for the sum of 10s. yearly (or 5s. if taken out after the 30th June), on any prescribed area of Crown lands: for gold, not exceeding 20 acres; coal, or shale, not exceeding 100 acres; any other mineral not exceeding 40 acres. Licences may have extended areas conceded to them of 320 acres.

(2) Any one over 21 years of age may apply for a lease of Crown land for a term of 21 years for mining purposes with statutory right of renewal. Gold leases are for areas not exceeding 20 acres, but where gold is associated with other minerals which form the principal product, or where any other mineral is mined, the leases may cover 80 acres. Leases to mine for coal, shale, slate, freestone, or limestone, must not exceed 320 acres. Larger areas can only be granted by the Minister with the consent of the Governor in Council. Leases for 10 years may be granted of river beds and banks at 5s. per acre per annum with right of renewal. Leases of Crown land for machinery sites up to 10 acres are granted for 21 years at 5s. per acre annual rental, with right to renewal.

(3) Any one above the age of 21 may mine on any area of Crown land not exceeding an acre, and such area shall be called a

[1] The laws have recently been amended and the labour covenants made more elastic.

miner's claim. He may construct and use races, roads, reservoirs, dams, tramways, or other works required for mining purposes on his miner's claim. He may build a dwelling and reside upon his claim, and cut firewood for domestic use on any Crown land.

($3\frac{1}{2}$) Water rights are granted for a term of 21 years, renewable, at annual rental of £1 per sluice head, carrying the right to construct races, dams, and reservoirs.

($3\frac{3}{4}$) Easement licences for a term of 21 years are granted to lessees at a rental of 5s. per acre per annum, or by length at a rental of 5s. per 40 chains per annum, for the conveyance of tailings and debris, construction of roads, tramways, tunnels, shafts, and subways.

(4) Gold leases are subject to a rental of £1 per acre per annum. Leases to mine for coal, shale, slate, freestone, or limestone, are subject to a rental of 2s. 6d. per acre per annum.

Other mineral leases are subject to a rental of 5s. per acre per annum.

Reduced rents are payable in the case of mixed ores with accessory gold. All leases are transferable.

(5) Covenants.—Holders of gold leases must employ in each half-year at the rate of at least one man for every 4 acres, or part thereof, for 40 hours per week (average), or at their option must spend half-yearly at least £10 per acre.

Holders of mineral leases must employ in each half-year at the rate of at least one man for every 20 acres, or part thereof, for 40 hours per week, or at their option spend half-yearly at least £2 per acre.

Holders of river leases must employ in each half-year an average of one man for every 20 acres, or part thereof, for 40 hours per week, or at their option spend half-yearly at least £2 per acre.

(6) Forfeiture.—If the lessee fails to comply with the conditions or covenants of his lease, he is liable to a penalty of £25 for the first default; and for the second or subsequent default to a penalty of £50, or forfeiture, at the discretion of the Commissioner. There is an appeal from the Commissioner's decision to the Mining Board (a Board consisting of the Minister, the Secretary for Mines, and the Commissioners, who meet to fix rents for the leases for mixed minerals, to grant lessees exemption from labour covenants from time to time, and to advise generally as to regulations).

Any person applying for the forfeiture of any lease by reason of non-execution of labour covenants, has, if the lease be forfeited in consequence, a prior right to a new lease.

(7) All mines have to be worked in accordance with regulations detailed in the Act. Inspectors of Mines see that the working rules are complied with. Provision is made for arbitration in matters considered by the Inspectors as dangerous, but not provided for specifically in the Act.

(8) Reward leases at a peppercorn rent are granted for terms not exceeding 21 years to any persons who discover minerals, under the following conditions:—

For gold, as regards distance in a direct line from gold known to exist in similar deposit: if more than 2 miles, not exceeding 10 acres; if more than 5 miles, not exceeding 15 acres; if more than 10, not exceeding 20 acres.

For other minerals: if more than 2 miles, not exceeding 80 acres for coal or shale, and not exceeding 20 acres for other mineral; if more than 5 miles, not exceeding 160 acres for coal or shale, and not exceeding 40 acres for other mineral; if more than 10 miles, not exceeding 240 acres for coal or shale, and not exceeding 80 acres for other mineral.

The most important and most steadily growing agricultural industry in Tasmania is the growing of fruit, vegetables, and fodder. The land under cultivation on March 3, 1903, was as follows:—

Grazing land, cleared	4,471,914	acres
Grazing land sown with introduced grasses	326,324	,,
Hay	66,038	,,
Oats	55,058	,,
Wheat	40,898	,,
Potatoes	34,625	,,
Barley	8,281	,,
Hops	665	,,
Fruit orchards, etc.	63,440	,,
	5,067,243	,,

The climate is well adapted for fruits, such as apples, pears, peaches, plums, cherries, walnuts, currants, etc. Those which can be exported frozen to England find a good market, as they arrive during the English winter.

The railways of Tasmania are mainly owned by the

State; but the lines from Emu Bay to Zeehan (88 miles), the Mount Lyell Railway (21½ miles), the line from Zeehan to Dundas, and the North Lyell Railway, from Kelly Basin on Macquarie Harbour to Linda, now practically closed, are all held by private companies. The State lines are 462 miles long, and cost £3,883,729, or an average of £8406 per mile; the lines are worked with a profit of usually a little over 2 per cent.

The main railway line runs across the island from Hobart to Launceston; a branch from Evandale, south of Launceston, goes north-westward to Latrobe and Emu Bay. Another branch from the main line goes to the east coast at St. Mary. A short line from Strahan to Zeehan connects the Mount Lyell and the Emu Bay Railways.

6. Towns in Tasmania

BEACONSFIELD (41° 9′ S. lat., 146° 6′ E. long.), in the county of Devon, on the west bank of the river Tamar, at the foot of Cabbage Tree Hill, 28 miles north-west of Launceston, is the chief gold-mining town in Tasmania. Population of town, 2658; of district, 6500.

BURNIE (40° 57′ S. lat., 145° 56′ E. long.), on Emu Bay, is the chief port in north-western Tasmania. It is the terminus of the Emu Bay Railway, which goes to the mining towns of Waratah, for the tin mines of Mount Bischoff, and Zeehan; and thence on to Strahan on Macquarie Harbour, whence another railway runs to the Mount Lyell mining-field. Another railway goes south-eastward from Burnie to Launceston, and thus to Hobart. Burnie is the nearest Tasmanian port to Melbourne. Population of the town about 1750; district, 7000.

DEVONPORT, East and West, formerly known as

Formby and Torquay (41° 9′ S. lat., 146° 22′ E. long.), in the county of Devon, stands on both banks of the river Mersey, near its mouth. It is in a rich agricultural and fruit-growing district, connected with Melbourne by steamers, and by rail with Burnie and Launceston. Population of the town, 3515; of the district, 7685.

FINGAL (41° 37′ S. lat., 148° 0′ E. long.), in the county of Cornwall, 120 miles north-east of Hobart, stands on the South Esk River, is in the chief Tasmanian coal-field. Population of the town, 372; of the district, 5831.

GLENORCHY (42° 49′ S. lat., 147° 16′ E. long.), a suburban town, 5 miles north-west from Hobart, on the western bank of the Derwent River, is in one of the best agricultural districts of Tasmania, growing grain, hops, and fruit. Population of the town, 732; of the district, 6226.

HOBART (42° 53′ 32″ S. lat., 147° 21′ 20″ E. long.), the capital of Tasmania, at the foot of Mount Wellington (4166 feet high), on the river Derwent, 12 miles from its mouth, is probably the most beautifully situated city in Australia. It combines fine estuarine and grand mountain scenery. The harbour is convenient for shipping. It is the second oldest city in Australia, and has many interesting old public buildings, a University, and schools. Population of city, 25,065; of suburbs, 9750.

LAUNCESTON (41° 30′ S. lat., 147° 14′ E. long.) is the second city in Tasmania, and is the commercial capital. It is situated on the Tamar River, 40 miles from its mouth, near its entrance to its estuary. It is prettily situated, and near it is the fine Cataract Gorge on a branch of the Esk River. It is a busy port, and has the large tin-smelting works of the Mount Bischoff Mining

Photo. *A. E. Kitson.*

CATARACT GORGE, LAUNCESTON, TASMANIA.

Company. It is 120 miles north of Hobart, and 267 miles south-east from Melbourne. The population, including suburbs, is 23,000.

STRAHAN, on Macquarie Harbour (42° 9′ S. lat., 145° 20′ E. long.), in the district of Montagu, is the principal port on the western side of the island, and was one of the famous penal settlements. Railways go inland through Zeehan to Emu Bay and up the King River to Queenstown. It is the port of the mining district of Mount Lyell. The population of the town is 1504.

WARATAH (41° 27′ S. lat., 145° 32′ E. long.) is the mining town beside the tin-mines at Mount Bischoff. It is in the county of Russell, 90 miles west of Launceston, and 47 miles south-west of Emu Bay. The population of the town and district is 4867.

NEW NORFOLK (42° 46′ S. lat., 197° 5′ E. long.), 21 miles north-west of Hobart, on the right bank of the Derwent River, is in a hop and fruit-growing district. Population of the town is 1151.

QUEENSTOWN, on the Queen River, in the county of Montagu, is the terminus of the Mount Lyell Mining Company's Railway, from the coast at Strahan. The smelting works of the Mount Lyell Mines are situated here. The mines are four miles away, near the towns of Gormanston and North Lyell, in the valley of Linda, a tributary of the King River, across the ridge which divides the Queen and King Rivers. Population of town, 5050, and of district, 10,451.

ST. HELEN (41° 21′ S. lat., 148° 15′ E. long.) is a watering-place at the head of a land-locked harbour on the eastern coast. It is in the county of Cornwall, and is the port for the tin-fields of Blue Tier and Thomas Plain districts. The population of the district is 5831.

ST. MARY (41° 35′ S. lat., 148° 15′ E. long.), a small


148°
CAPE BARREN I^d.
Armstrong Channel
C. Barren
Clarke I.
BANKS STRAIT

coal-mining town, in Eastern Tasmania, in the county of Cornwall, 80 miles east of Launceston. Population of town, 281; of district, 5881.

STANLEY (40° 46′ S. lat., 145° 17′ E. long.), a seaport in the county of Wellington, on the north-western coast, west of Burnie. Behind it is one of the best pastoral districts in the State. Population of the district is 5565.

ZEEHAN (42° S. lat., 45° E. long.), in the county of Montagu, is the chief silver-lead mining town in Tasmania. It is on the Little Henty River. It is the terminus of the railways for Strahan and Emu Bay; branch lines go to the mines around Dundas. It has the chief School of Mines in Tasmania. Population of town, 5014; of the district, 6672.

The literature for Tasmania includes:—

Handbook of Tasmania, with List of Reference Works on the Agricultural, Pastoral, Horticultural, and Mineral Resources of the Colony. Launceston, 1899, pp. 32.

Murray, A. S. *Tasmanian Rivers, Lakes, and Flowers.* 1900, pp. 58.

Fysh, Philip O. "Tasmania: Primitive, Present, and Future," *Journ. R. Col. Inst.* xxxi. (1900), pp. 153-179.

Twelvetrees, W. H. "Outlines of the Geology of Tasmania," *Papers and Proc. R. Soc. Tasmania* (1900-1901), pp. 58-74.

Bell, C. Napier. "Macquarie Harbour, its Physical Aspect and Future Prospects," *Papers and Proc. R. Soc. Tasmania*, 1898-1899, pp. xxviii.-xxxiii.

Hogben. "The Tasmanian Earthquake, 27th Jan. 1892," *Trans. New Zealand Inst.* (1899), pp. 594-601.

Kayser, H. W. Fred. "Mount Bischoff," *Rep. Austr. Assoc. Adv. Sci.* iv. (1893), pp. 343-358. Map.

Legge, W. V. "Physiographical Account of the Great Lake, Tasmania," *Austral. Assoc. Adv. Sci.* vol. x. 1905, pp. 348-375, and maps.

Also the Transactions of the Royal Society of Tasmania and the Reports of the Department of Mines and of the Geological Survey.

CHAPTER XV

SOUTH AUSTRALIA

SOUTH Australia is the second largest of the Australian States. The Colony was projected and named before there were any permanent settlements on the southern coast of Australia, the middle part of which was allotted to it. The Charter granted it the land between the meridians of 132° and 141°, and as far north as the 26th parallel. The name of South Australia was then appropriate. But the Colony was enlarged in 1861 by extension westward to the 129th meridian, and in 1863 the land to the north of the 26th parallel was added as the "Northern Territory." It thus included the centre of the continent, and reached the northern coasts in Arnhem's Peninsula. It thus extends in a broad belt across the whole width of the continent, and the largest part of the State lies within the tropics. It includes more of tropical Australia than any other State, so that its name is misleading, and Centralia, which has been suggested, would be more accurately descriptive.

South Australia touches all the other States; it is bounded on the west by Westralia, and on the east by Victoria, New South Wales, and Queensland.

The Victorian boundary is in dispute to the extent of two miles. The eastern frontier was defined at the 141st

meridian; and owing to the difficulty of precisely determinating a meridian in an unsettled country, it was fixed somewhat too far to the west. The Victorian Railway terminus at Serviceton is on territory that, according to the Constitution, should have been within the territory of South Australia. The northern boundary was originally the 26th parallel of latitude; but in 1863 the area of the Colony was enlarged by the addition of the territory to the north of that line as far as the northern coast. This district is known as the Northern Territory. The present area of the State, south of the 26th parallel, is 380,070 square miles. The land in the Northern Territory consists of 523,620 square miles, giving a total of 903,690 square miles, or 578,361,600 acres.

The history of the Colony dates from the provisional grant of this part of the continent by the British Government, in 1834, to the South Australian Colonisation Association. This Association was established largely owing to the efforts of Gibbon Wakefield, to found a model experimental colony. Its revenue was to be obtained by the sale of land, at a minimum price of 12s. per acre; and the proceeds of the land sales were to be applied to the transport of suitable emigrants from England, and their establishment in South Australia. The Governor was appointed by the Crown, and the Commissioners who managed the Colony had to be approved by the British Government. The first body of emigrants were taken out and landed on Kangaroo Island in 1836. The site of Adelaide was selected for the capital by Colonel Light, and the first Governor, Sir John Hindmarsh, arrived there on the 28th of December 1836. The first sale of the town allotments took place at Adelaide in 1837.

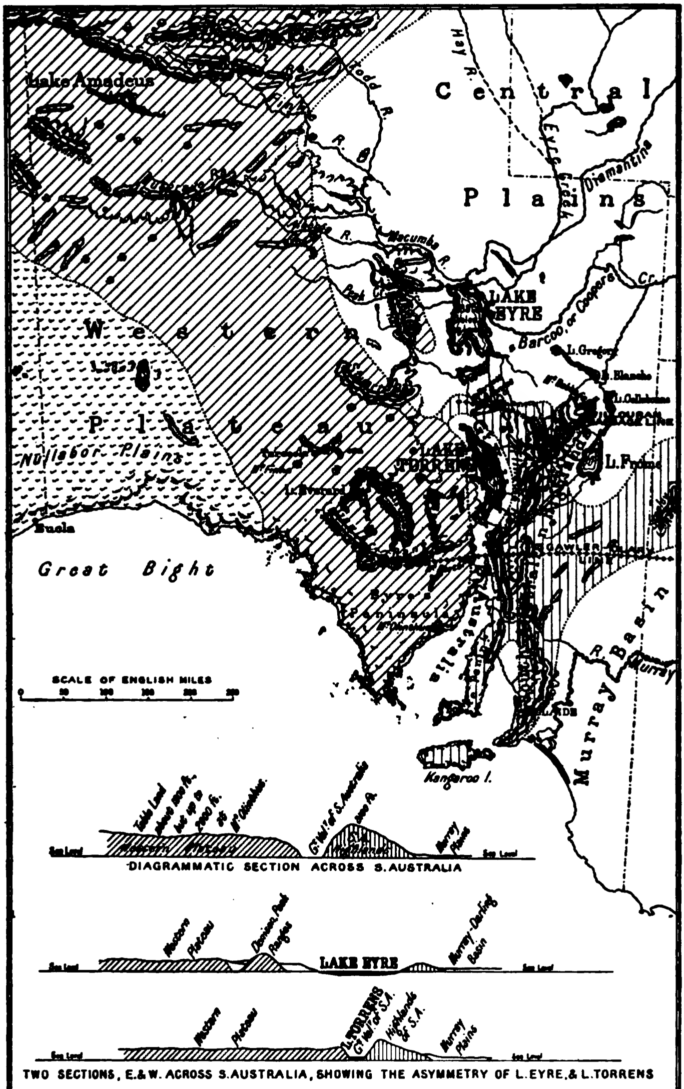
The first period in the history of the Colony was very unsettled, owing to difficulties between the Colonisation Association, the Governor, and the British Government. The conflicts between Hindmarsh and the colonists soon led to his recall. His successor, Gawler, was also recalled, in 1841, owing to his extravagant expenditure on public works; he raised the money by drafts on the Home Government, which it repudiated. The success of the State was first established by the Government of Sir George Grey, between 1841 and 1845. He reduced the expenditure to a third of the amount spent by his predecessor; the extent of land under cultivation and in pastoral occupation increased, while the fortunate discovery of copper aided his statesmanlike policy. The success of the mines at Kapunda, Wallaroo, Moonta, and Burra-Burra brought prosperity to the Colony; and before some of these mines were exhausted, the agricultural and pastoral industries were so well established that permanent success was assured.

The exploration of the State is briefly described on pp. 63, 68-73, 75-76, 78.

1. The Geographical Divisions

South Australia may be divided into four natural divisions. The southern district, which was first settled, is divided into two parts by the Great Valley of South Australia, occupied by Spencer Gulf and Lake Torrens. This valley is a rift valley, formed by the foundering of a long strip of country between two long, parallel series of faults. The high plateau, which originally extended across this valley, has now been broken by its formation into two parts.

The Great Valley of South Australia includes the



THE GEOGRAPHICAL DIVISIONS OF SOUTH AUSTRALIA.

Spencer Gulf with its branch, the St. Vincent Gulf, and the vast expanse of salt swamps and salt marshes known as Lake Torrens. It also includes the low-lying coastal plains around Adelaide and Gawler, and along the shores of Spencer Gulf past Port Pirie, Port Germein, and Port Augusta to Lake Torrens.

To the east of the Great Valley are the Highlands of South Australia, which face the west with a high scarp, known by various names during its course from north to south.

The scarps and hill lines on the western side of the Highlands going from south to north are the Bluff Range, Sellick's Range, Bull's Creek Range, Mount Lofty Range, Gould Range, Gregory Range, Campbell's Range, Flinders Range, Ragless Range, Yappala Range, and Elders Range. The hills and slopes to the east, overlooking the Murray basin, are known, again going from south to north, as the Bremer Range, Mount Pleasant Range, the Murray Ranges, Two Hills Range, Bald Hill Range, and Mount Bryan. On the western edge of the Highlands, above Port Augusta, are the two highest peaks in South Australia (excluding the Northern Territory), Mount Brown (3200 feet) and Mount Remarkable (3178 feet). The elevations on the middle line of the northern Highlands include Point Bonney and Mount Serle, and in the southern Highlands, the Camel's Hump Range and the Brown's Hill Range.

The surface of the South Australian Highlands is that of a weathered plateau, with a general slope downward to the east. The surface is gently undulating, for though the plateau was probably once dissected by river action, the small rainfall is unable to remove the debris formed by the decay of the rocks; the material thus collects in the floors of the old valleys, and forms plains

that look like old lake basins. The soil on these plains is deep and rich, and, in spite of the low rainfall, these waste-filled basins on the Highlands are the chief wheat-growing district of South Australia. The Highlands are traversed by the South Australian Railway from Freeling to Quorn, whence a branch line runs down the Pichi Richi Pass to Port Augusta. From Quorn the

A WIND GAP IN THE SOUTH AUSTRALIAN HIGHLANDS, 20 MILES FROM BELTANA.

line continues northward over the Willochra basin, and after passing Hawker it runs down a narrow gorge through the Flinders Range, on to the floor of the Great Valley near Mount Eyre. The South Australian Highlands extend still farther north, including the mining country east of Parachilna and Beltana; and further on the old rocks of which they are composed plunge beneath the plains of the Lake Eyre basin.

The eastern boundary of the South Australian Highlands is a well-marked scarp, at the foot of which are the plains of the Murray basin on the south, and of Lake Frome on the north. To the east of Port Augusta, the Highlands extend eastward, and enter New South Wales.

To the west of the Great Valley is another ancient tableland—the Western Plateau. Its surface is often about 1300 feet above sea-level, but it rises on its eastern edge at Mount Olinthus to 2000 feet, which, like the highest peaks on the Highlands, occurs on the edge overlooking the Great Valley.

The surface of the Western Plateau is studded with numerous lake basins, which are nearly always dry. The largest of them are—Lakes Gairdner, Everard, Harris, Macfarlane, Gilles, and Windabout. The Western Plateau projects southward into the Southern Ocean as the Eyria Peninsula. The eastern scarp of the plateau west of Port Augusta is known as the Baxter Range. Its north-eastern edge is known in part as the Stuart Range.

The most obvious geographical features of the southern part of South Australia is the division into four areas arranged meridionally. But traces are recognisable of an older east and west course of the main geographical lines. Thus Kangaroo Island is a line of very old rocks trending east and west. The central axis of the plateau west of Lake Torrens appears to be the granitic rocks of the Gawler Range; and this line crosses the Great Valley at Port Augusta and thus separates the Torrens basin from Spencer Gulf; it is continued eastward and includes the granitic hills about Olary.

North of the Gawler-Olary line is a third east and west line, best seen in the old rocks of the Hergott Ranges. This line extends from Mount Babbage on the east to the Willouran Hills on the west.

The structure of South Australia to the north of the Willouran-Babbage line is strikingly unlike that of the southern districts. The Murray-Darling basin has passed far eastward into New South Wales; hence the eastern frontier and the northern continuation of the

Photo. *H. J. Grayson.*

STONY DESERT, FORMED BY THE WASTE OF THE DESERT SANDSTONE, NEAR LAKE EYRE.

South Australian Highlands is occupied by the vast plains of the Lake Eyre basin.

These plains are based on a vast sheet of marine clay, capped by tablelands, flat-topped hills, and ridges of Desert Sandstone. The wearing away of this rock leaves the surface of the clay beneath littered with closely packed pebbles, forming the "Stony Desert." The plains end sharply against the northern foot of the

Highlands; though one patch of the marine deposits occurs beside the northern end of Lake Torrens. It may have been faulted down to its present position.

The western border of the Lake Eyre basin is formed of a line of ranges of old rocks, which are geologically a continuation of those of the South Australian Highlands. This series of ranges runs north-westward from the Willouran Range. Its chief members are the Denison Range, Peak Range, and Kingston's Range. These old ranges rise like islands surrounded by the Mesozoic marine rocks of the Lake Eyre plains. These Mesozoic rocks, however, end off to the west, against the Stuart Range, the hills to the east of Wintana, Mount Mystery, and the Anthony Range, which are all on the great Archean plateau of Western Australia.

Crossing to the Northern Territory the old rocks are found to constitute a series of ranges trending east and west. These ranges may be grouped together as the Macdonnell Chain. It consists of many parallel ranges, including the Birksgate Range, Tomkinson Range, Deering Range, Musgrave Ranges, Mann Range, George Gill Range, Macdonnell Range, and Hart Range. The James Range and the Arltunga Goldfield occur near the eastern end of the Macdonnell Chain.

The Lake Eyre basin lies to the east of the Denison-Peak Ranges, and it occupies an area of subsidence which, as proved by the railway levels, has carried the surface below the level of the sea. The southern shore of South Lake Eyre is 36 feet below sea-level.

This subsidence has converted Lake Eyre into a basin of internal drainage. Its former outlet was probably south-eastward to the Darling.

Lake Eyre is now usually a plain of salt lakes and salt swamps. The northern part is about 85 miles long,

with an average breadth of about 45 miles. Vast floods from the Queensland Hills are poured into it, down the Barcoo and the Diamantina, and then, for a time, the lake contains salt water. But it soon evaporates; for the rivers only run occasionally, and for years together they

Photo. *H. J. Grayson.*

A WATER-HOLE ON THE DIAMANTINA RIVER AT KALAMURINA, LAKE EYRE DISTRICT.

consist of a chain of water-holes, containing concentrated brine.

When first seen, Eyre regarded Lake Eyre as part of a vast horseshoe-shaped lake, surrounding the South Australian Highlands on all sides but the south. But the work of Babbage, Stuart, Parry, Stuckey, A. C. Gregory, and Freeling proved that Eyre's lake consists of a number of disconnected lakes. This fact was first proved by Babbage in 1858. This lake chain consists

of Lake Torrens, Lake Eyre, Lake Florence, Lake Gregory, Lake Blanche, Lake Callabonna, and Lake Frome.

2. The Geology of South Australia

The geology of South Australia is specially instructive, as the State includes a belt stretching right across the continent from south to north, including the centre of Australia. It connects the old Archean plateau of Westralia with the Palæozoic Highlands of Eastern Australia; it has representatives of all the geological systems found in Australia, with by far the best development of the Cambrian.

South Australia can be most conveniently considered as divided into three distinct divisions: the southern, the Lake Eyre basin, and the Northern Territory. The southern division consists in the main of a block made up of Archean and Lower Palæozoic rocks, which once extended east and west throughout Southern Australia from Westralia to Victoria; it was, no doubt, at one time continued far to the south of the present limits of the continent. The Archean rocks once extended westward to join the great Westralian plateau, and they can be followed eastward till they disappear beneath the alluvial deposits of the Murray and the Darling; while to the north-east they can be followed across the frontier of New South Wales to Broken Hill.

The Archean rocks, which occur along the eastern border of the Mount Lofty Ranges, form the backbone of Kangaroo Island, where they strike from west to east. On the mainland they first trend eastward, and then sweep round to the north behind Aldinga, and strike northward till they disappear, owing to the transgression of the

Cainozoic rocks of the Murray basin on to the Cambrian rocks of the South Australian Highlands. The Archean rocks also occur in the York Peninsula and in the Eyria Peninsula to the west of Spencer Gulf; they reappear in the north-eastern part of the South Australian Highlands to the west of Lake Frome, and in the Termination Range south of Hergott.

The Archean series is accompanied by masses of Plutonic rocks, which are probably, in part, of the same age. These rocks are developed near the New South Wales border, to the west of Broken Hill; there they appear to be brought up as the eastern end of a range, which is buried beneath the Highlands of South Australia. To the west of Spencer Gulf and Port Augusta, these

Photo. *J. W. Gregory.*

A SALT-WATER POOL ON THE DIAMANTINA RIVER, NEAR KALAMURINA, LAKE EYRE DISTRICT.

rocks widen out as the great sheet of granitic rocks of the Gawler Ranges; they extend from Reed's Look Out on the east to the south of Lake Gairdner, and they are continued by occasional outliers, such as the Warburton Range, until they disappear beneath the Middle Cainozoic limestones of the Nullabor Plains.

The Archean rocks must, in Cambrian times, have formed a high mountain chain, from whose snow-clad summits glaciers flowed down the flanks and deposited the Cambrian glacial deposits discovered by Mr. Howchin of Adelaide. These Cambrian glacial deposits are one of the most interesting of the geological formations in Australia. They occur at intervals for 150 miles to the north of their outcrop south-east of Adelaide. The suggestion has been made that they are only crush-conglomerates; and they have been so much affected by subsequent earth-movements, that many of the boulders and pebbles have been sheared, and the displaced fragments re-cemented. But the shearing did not give the beds their glacial characters, and Mr. Howchin's explanation is accepted by Professor David, Mr. Pittman, and myself, after personal examination of the sections.

The Cambrian deposits of the Mount Lofty Ranges, to the east of Adelaide, are a series of highly tilted rocks trending from north to south. They rest upon Archean beds to the east. The Cambrian rocks have a great development in South Australia. They occur at intervals, from south to north, across the whole of the State. They are well developed in the ranges behind Adelaide, and extend thence north to Beltana, in the Highlands to the east of Lake Torrens. They have yielded a rich Cambrian fauna, including the following fossils:—

Ethmophyllum hindei, Eth. fil.
Protopharetra (?) *scoulari*, Eth. fil.
Coscinocyathus tatei, Eth. fil.
Olenellus pritchardi, Tate.
Microdiscus subsagittatus, Tate.
Dolichometopus tatei, Woodward.
Ptychoparia australis, Woodward.
P. howchini, Eth. fil.
Orthisina compta, Tate.
Ambonychia macroptera, Tate.
Platyceras etheridgei, Tate.
Ophileta subangulata, Tate.
Stenotheca rugosa, Hall.
Salterella planoconvexa, Tate.
Hyolithes communis, Bill.
H. conularoides, Tate.

The age and correct succession of the Cambrian rocks of the Mount Lofty Ranges have been much discussed among Australian geologists. They have all been assigned to the Archean, and the schists and gneisses of the eastern part of the area have been described as younger than the slates and less crystalline rocks on the western border. The correct sequence has been established by the work of Mr. Howchin. The schistose and gneissose rocks on the eastern border of the area, where the rocks sink below the alluvium of the Murray, are no doubt of Archean age; and they are covered by a great series of rocks of Cambrian age, which form the main mass of the Mount Lofty Highlands. The order of succession in the Cambrian beds, established by Mr. Howchin, is as follows:[1]—

(*a*) Purple slates, quartzites, and limestones — at Marino, Halletts Cove, Lower Onkaparinga.

(*b*) Siliceous, blue, pink (oolitic), and dolomitic limestones— Brighton, Field River, Hackham, etc.

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[1] W. Howchin, "Geology of the Mount Lofty Ranges," *Trans. R. Soc. S.A.* vol. xxviii. 1904, p. 259.

(*c*) **Banded, fine-grained clay slates and shales — Tapley's Hill, etc.**

(*d*) **Glacial till, grits, etc., with erratics—Sturt River, Onkaparinga River, etc.**

(*e*) **Siliceous and felspathic quartzites and phyllites—Mitcham, Glen Osmond, Magill, etc.**

Both these Archean and Cambrian beds extend from the southern coast of South Australia, northward behind Adelaide, into the great wheat-growing tableland to the east of Spencer Gulf. Thence they continue northward through the Highlands to the east of Lake Torrens. They send out one arm to the north-east round the eastern side of Lake Frome. Due northward the Cambrian and Archean rocks sink beneath the Mesozoic deposits of the Lake Eyre basin; but they are prolonged to the north-west, through the Termination Range, to the south of Lake Eyre, and then through the Peak and Denison Ranges to the west of that lake.

The Peak and Denison Ranges are disconnected fragments, separated by sheets of Cretaceous and Cainozoic rocks;[1] but there can be no doubt that at one time they were part of a continuous band which connected the Highlands of South Australia with the plateau of Central Australia.

Still farther north the Archean rocks are well developed in the Macdonnell Ranges. The Cambrian rocks reappear near Alexandrina, and at Elkedra, in the Northern Territory. According to Mr. Brown, the unfossiliferous sandstones of Central Mount Stuart, and other peaks in the Macdonnell Ranges, also belong to the Cambrian system.

The south-western part of South Australia consists

[1] For their structure, see H. Y. L. Brown, Report of the Government Geologist of S.A. for year ending 30th June 1894, pp. 13-15. Plates and sections.

mainly of an old plateau of Archean rocks, with intrusive granites; it forms the country to the west of Lake Torrens and the Spencer Gulf. The plateau is capped in places by horizontal beds of sandstone, referred doubtfully to the Devonian. To the south-west, the rocks of the plateau, and also those of the coast on the eastern side of the Spencer Gulf, are flanked by the Middle Cainozoic limestone of the Nullabor Plains. Limestones, sandstones, and clays of the same age form the south-eastern corner of South Australia. They extend up the Murray basin. They are well known and rich in marine fossils at the great north-western bend of the Murray, and though covered by river silts, extend up the Darling into New South Wales. These rocks are also well shown at Aldinga on the coast, south of Adelaide.

The Lake Eyre basin occupies the central part of South Australia. It is bounded on the south by the Highlands of South Australia, and on the west by the Peak and Denison Ranges. Its western and southern boundaries are formed by the Archean rocks, which are covered by a series of terrestrial deposits of Jurassic age. These rocks, in places, are 2000 feet in thickness. They contain seams of brown coal, which have been worked at Leigh's Creek and have been passed through by the bore at Lake Phillipson. The Leigh's Creek deposits sink to the north beneath the vast series of clays, which were laid down beneath the sea in Cretaceous times, as the southern extension of the Rolling Downs Formation in Queensland.

The Jurassic beds of Leigh's Creek had a considerable extension to the northward of that locality, as the presence of *Phyllopteris feistmanteli* at Ooroowilanie Swamp shows the occurrence of an outcrop of these beds on the northern side of Cooper's Creek; and beds of the

same age have also been found in the Lake Phillipson bore, to the west of the Denison Range. The Jurassic age of these coal-beds is shown by the fact that their typical fossil, *Phyllopteris feistmanteli*, also occurs in the coal-field of the Styx River, to the south of Broad Sound Bay in Queensland, in rocks of the Burrum series.

The Cretaceous clays of the Lake Eyre basin are of great importance, as they form the impermeable cap under which are imprisoned vast stores of water, accessible by deep wells. Some of these wells, such as that at Dulkaninna, yield 1,000,000 gallons a day each. The bore at Kopperamanna, 3000 feet deep, yields 800,000 gallons a day, the water varying in temperature from 176 to 185 degrees. The fossils from these clays have been obtained in fragments from the bores; and the outcrop of the clays on the western side of Lake Eyre has yielded abundant Mollusca and Belemnites, and Mr. Sweet has obtained remains of Plesiosaurus. The Mollusca include:—

Lingula subovalis, Dav.
Pseudavicula australis, Moore.
Maccoyella barklyi, Moore.
M. corbiensis, Moore.
Lima randsi, Eth. fil.
Pinna australis, Hud.
Mytilus rugocostatus, Moore.
Belemnites australis, Moore.
B. canhami, Tate.
Crioceras australe, Moore.

The rocks are usually assigned to the Lower Cretaceous; but some of the palæontological evidence suggests that there may be also beds of Upper Cretaceous age. These deposits were laid down in a sea which extended southward from the Gulf of Carpentaria as far as

the northern end of Lake Torrens. To the south of that point there must have been, in Cretaceous times, a great belt of land, which prevented the marine clays being laid down farther to the south, though they spread out some distance to the south-west. The clays of the Rolling Downs Formation were covered by a vast sheet of Desert Sandstone, now broken into isolated, table-topped hills, and occasional peaks and ridges. This Desert Sandstone was laid down to some extent under water, but partly on land. It is probably of Upper Cretaceous age, but the palæontological evidence in South Australia is insufficient to determine its exact horizon.

The later deposits of the Lake Eyre basin are Upper Cainozoic in age, and are to be regarded as probably Upper Pliocene and Pleistocene. They are a great series of estuarine clays and silts which were laid down in the deltas of the river which flowed from Queensland into Lake Eyre. These deposits are rich in fossil marsupial remains, including those of the giant marsupial Diprotodon, and there are also bones of crocodiles, giant lizards, and water-birds; the Dingo and Thylacinus also lived during the deposition of these beds, but there are no signs of the presence of contemporary man.

The geology of the southern part of the Northern Territory is characterised by the trend of the rocks from east to west. This arrangement is foreshadowed in the north-western part of the Lake Eyre basin, by the marked divergence of the rocks from their normal meridional trend. In the Petermann, Macdonnell, James, and Stuart Ranges the trend is almost west and east; but farther northward the strike of the beds again trends to the north-west. Amongst these ranges, the Petermann Range, to the north of Lake Amadeus, and the Treuer

Range are composed of granites; the George Gill Range, near Tempe Downs, the Macdonnell, James, Buxton, and Hart Ranges are composed of Archean and Ordovician rocks. The most interesting rocks in this group of ranges are Ordovician in age; they consist of pale-coloured micaceous sandstones and shales. Mr. Thornton has collected in them, near Tempe Down, an abundance of fossils, including such characteristically Ordovician forms as *Asaphus thorntoni*, *A. howchini*, *Endoceras warburtoni*, found north of Tempe Downs station, and of Ordovician brachiopods from Petermann Creek, and probably also from the George Gill Range.[1] Ordovician fossils also occur in the quartzites of Mount Watt (25° 20′ S. and 133° 54′ E.).

The collection made on behalf of the Geological Survey of South Australia, and described by Mr. Etheridge, and the important collection by the Horn Expedition have yielded a rich Ordovician fauna. Rocks of this age extend eastward across the Queensland border, and in the other direction they will probably be found to extend into Westralia. To the west they may be diverted north-westward, a change of which there is an indication in the Buxton Range; and they may be continued in the well-known Lower Cambrian area of the Kimberley Goldfield.

A second series of Lower Palæozoic sedimentary rocks include a series of limestone and dolomites, with clays, quartzites, sandstones, and slates, which form the Ooraminna Range, and the James Ranges; though no fossils have yet been found, Mr. Brown regards these rocks as of Cambrian age, from their lithological resemblance to rocks in the South Australian Highlands, which yield

[1] R. Etheridge, jun., "South Australian Lower Silurian and Mesozoic Fossils," *Parl. Pap. S.A.* No. 23, 1892.

Cambrian fossils. Cambrian rocks unquestionably occur a short distance farther to the north: thus at Elkedra station, to the north-east of Barrow Creek, in lat. 21° S., long. 135° 20′ E., they have yielded such unmistakable Cambrian genera as Agnostus and Microdiscus; and still farther to the north-east, near Alexandria station, occur fossils determined by Mr. Etheridge as *Olonellus browni*. The rocks, therefore, belong to the lowest part of the Cambrian.

The best-known area in the Macdonnell Ranges is the Arltunga Goldfield, to the north-east of Alice Springs Telegraph Station. Gold was first discovered here in 1887, but the progress of the field was slow. In 1897, H. Y. L. Brown,[1] the Government Geologist, surveyed the field, and a year later a Government Battery was erected. The yield of gold from February 1898 to May 1903 amounted to £18,824. There was a great "boom" in the goldfield in 1903, which led to a re-examination of the area by Mr. Brown,[2] whose report showed that the evidence available did not justify the over-sanguine anticipations that had been formed about the field.

The country around the goldfields is at a height of about 2500 feet, and the ranges on it rise 1000 to 1200 feet higher: thus Mount Campbell in the Hart's Range is reported by Brown as 3670 feet high.

The Northern Territory contains a further series of rocks which are no doubt of Palæozoic age. They are known as the Victoria River sandstones and slates, and

[1] H. Y. L. Brown, Reports on the Arltunga Goldfield and Hart's Range Mica Field, 1897. Also, *Contributions to the Palæontology of South Australia*, by R. Etheridge, jun.

[2] H. Y. L. Brown, Report on the Gold Discoveries near Winnecke's Depôt and Mines on the Arltunga Goldfields, Macdonnell Ranges, 1903, pp. 8. Plan and Appendices.

include beds of crystalline limestones. No fossils have yet been discovered in them, but they are described by Brown as being probably of Carboniferous age. At Treachery Bay there is an occurrence of marine rocks belonging to the Carboniferous series, and fossils collected there by Brown have been determined by Etheridge as "most certainly of Carboniferous age." They include:—

Orthis australis, M'Coy.
O. michelini, Lev.
Aviculopecten murchisoni, M'Coy.
Mourlonia expansa.
Bellerophon hiulcus.

The Mesozoic system in the Northern Territory is represented by the shales, sandstones, and conglomerates at Port Darwin, and by some shales containing marine fossils at Port Charles, including Ammonites allied to *A. varians* and *A. guettardi*, with an Aucella of a different species from the *A. hughendenensis* of Queensland.

The occurrence of an Ammonite of the *varians* type suggests that these beds are Cenomanian rather than Neocomian.[1]

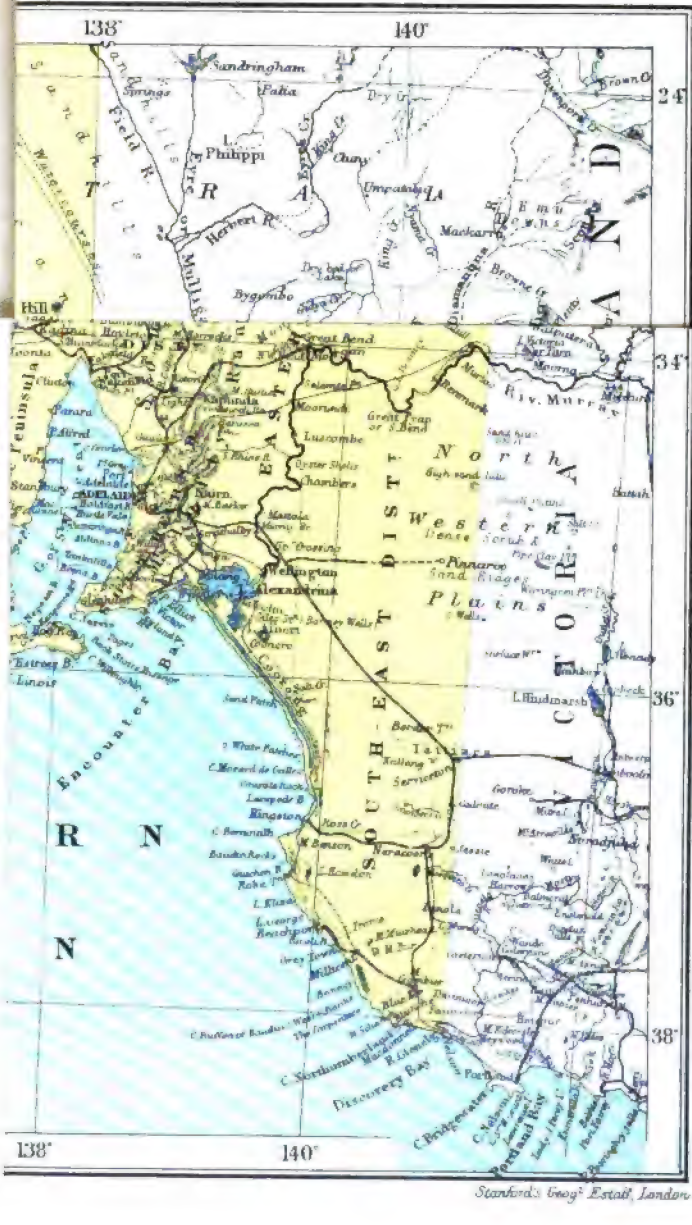
In the southern part of the Northern Territory there is a continuation of the Rolling Downs Formation.

The Northern Territory also includes an extension of the Desert Sandstone, and a series of shales and recent deposits in the coastal district.

3. The Northern Territory

The Northern Territory consists of the middle part of the northern half of Australia. It is bounded by the meridians of 129° E. and 138° E., and on the south by the parallel of 26° S. Its area is 523,620 miles; so that

[1] Report on the Northern Territory, pp. 33-34.



Stanford's Geog^l Estab^t, London

it is equal to all Western Europe west of Germany, Austria, and the Balkans, excepting Spain. The coasts were visited in prehistoric times by Malay fishermen, and were early explored by the Dutch. The first British settlement was at Melville Island in 1824, followed by the more important station at Port Essington on Port Darwin, which was kept up from 1831 to 1850. The Port Essington settlement was the cause of Leichhart's two expeditions, which were intended to discover a practicable route to it from Brisbane. A third temporary settlement, Gladstone, was established in the valley of the Roper River.

Stuart's reports as to the value of the northern country led to its annexation to South Australia on the 6th of July 1863; and a colony was landed in 1864 in Adam Bay. A larger expedition under Goyder, Surveyor General of South Australia, was sent in 1869, and in 1870 he transferred the settlement to Palmerston on Port Darwin, the present capital of the Northern Territory.

Geographically the Northern Territory may be divided into three parts: the Northern Peninsula of Arnhem Land; a central area of arid plains; and the southern plateau crossed by the ranges of the Macdonnell Chain. The peninsula of Arnhem Land projects to the north, between the Gulf of Carpentaria on the east and a great bight from the Indian Ocean on the west. It is bounded to the south-west by the Victoria River, which opens to the Indian Ocean through Queen's Channel, and to the south-east by the Roper River, which flows through Limmen Bight into the Gulf of Carpentaria. The interior is a tableland, the height of which was at one time exaggerated, owing to a misreading of Leichhart's notes. It appears to vary from 300 to 500 feet above the coastal

plains, and to rise to 1700 feet near the Victoria River. The extent and even the existence of the tableland has been the subject of dispute. It consists of a nucleus of old rocks, surrounded by a sandstone platform.

The Arnhem Land plateau is drained by several large rivers, some of which are navigable for a considerable length. On the western coast there is the Victoria River, navigable for about 110 miles from its mouth, and the Daly River. On the northern coast is the Adelaide River, the South Alligator and the East Alligator Rivers, all navigable for from thirty to forty miles. On the east coast is the Roper River, which is navigable for over 100 miles.

The rainfall on the plateau is less than on the coast plains, and the soil is less fertile. The most promising industries are pastoral and mining.

The coastal district is a low flat belt from 30 to 100 miles in width. The coast is fringed with sand dunes, beaches, and mangrove swamps, but it has some rocky headlands and the fine harbour of Port Darwin. The coastal districts rise inland, on an average, about five feet in the mile. The river valleys that run down to the sea are separated by low ridges of old rocks, which rise to a height of from 50 to 100 feet.

The north-western coast is indented by long bays separated by sinuous peninsulas, of which the most important is the Coburg Peninsula, on the northern side of Van Diemen's Gulf; Dundas Strait and Clarence Strait, the entrances to that gulf, occur one on each side of Melville Island, which is a continuation of the Coburg Peninsula.

The soil of the coastal district is rich and fertile, and can grow any tropical produce. It has an abundant rainfall, that at Port Darwin being in 1896, 67·36 inches;

in 1897, 73·99; in 1898, 57·97 inches; in 1899, 59·27 inches; and in 1900, 47·87 inches. The average is about 65 inches.

The chief settlement and capital of the Northern Territory is on Port Darwin, on the south-western coast of the northern section of the territory. Port Darwin is the second finest harbour in Australia. It is subject to higher tides than most of the Australian ports, the spring tides having a rise and fall of as much as 24 feet. The township is named Palmerston, whence a railway starts southward to Pine Creek, a length of 146 miles.

To the south of Arnhem Land the rainfall decreases, the country becomes arid, and extends as a series of barren plains from Daly Water to the Macdonnell Chain. These plains extend eastward to the Barklay Tableland and the basin of the Georgina in western Queensland, and westward to the Westralian frontier; and they are bounded to the north by the plateau-scarp, rising above the coastal plain, along the shores of the Gulf of Carpentaria. The rocks of these plains are mainly Archean; but in the downs to the east of Tennant's Creek there are some Cambrian beds. The plains rise gradually from Newcastle Water, 700 feet, and Powell's Creek, 1000 feet, to Tennant's Creek, 1300 feet, and Barrow Creek, 1700 or 1800 feet. The mountain which Stuart named the central point of the continent, and now known as Central Mount Stuart, is on these plains; but as it is only 470 miles from the northern coast in the Gulf of Carpentaria, and is 710 miles from the nearest point on the southern coast, at the Great Bight, and 790 miles from the head of Spencer Gulf, it is some distance from the geographical centre of Australia.

To the south of these plains occurs the old plateau traversed by the Macdonnell Chain, which consists of

parallel ranges trending approximately east and west, and including the Campbell, Treuer, and Reynolds Ranges to the north; the Macdonnell, Hart, James, Ehrenberg, and Ferguson Ranges along the central line; and the Petermann, Tomkinson, Musgrave, and Bagot Ranges to the south. These ranges rest on a plateau, of which the elevation on the Burt plain is about 2600 feet; and near Hermansburg, at the head of the Finke River, is 2000 feet. The ranges rise to the height of about 5000 feet. The mountains are cut through by deep transverse gorges, which date from a period earlier than the denudation of the ranges themselves. They are obviously old consequent rivers, earlier than the existence of the east and west valleys, cut out by subsequent rivers along the strike of the rocks. The country is well described by Professor Spencer in the narrative of the Horn Expedition.

Hitherto the colonisation of the Northern Territory has been disappointing. The early settlements at Port Essington and Gladstone[1] were abandoned, and the administration of the territory has been a heavy burden on the State of South Australia. The country has scattered mineral wealth.[2] Gold was first discovered in the Territory in 1870, by a man named Gandy, who was working on the Overland Telegraph line. There was a mining "rush" in 1872, when 4000 white settlers prospected the country. The quantity of gold exported between 1881 and 1900 was £1,639,908, as well as some copper, tin, and silver. The Arltunga Goldfield, in

[1] Hogan, J. P., *The Gladstone Colony: an Unwritten Chapter of Australian History*, London, 1898, pp. vi. and 278.

[2] An account of the commercial resources has been summarised in a *Report on the Northern Territory of South Australia. Its Natural Features, Pastures, Minerals, Present Resources, and Future Possibilities.* Issued by the National Association to Federalise the Northern Territory, Melbourne, 1902, pp. 38 with map.

the southern part of the Territory, had a mining "boom" in 1903.

The Territory has unquestionably great economic resources, and its coasts face the greatest potential market in the world; for its magnificent harbour at Port Darwin is only four days' steamer journey from that southern-eastern corner of Asia which is occupied by nearly one-half of the human race.

4. Economic Geography

South Australia is divided politically into three areas. The chief settlements and all agricultural work are confined to the South-eastern Division, which is known as "The Counties," because it is subdivided into 46 counties. It includes 51½ million acres, and occupies the country to the east of Spencer Gulf and the coastal districts of the Eyria Peninsula. The rest of the State is divided into the Western Division, which includes the plains to the north of the Great Australian Bight and thence eastward to Lake Torrens; and the Northern Division, which includes all the country to the north of Lake Torrens and of the South Australian Highlands.

The division known as "The Counties" is subdivided into five parts:—(1) The Central Division extends from the shore of St. Vincent Gulf, past Adelaide, and over the Mount Lofty Ranges to the Murray. It has a rainfall of 21 inches at Adelaide, and 42 inches in the Highlands at Mount Lofty. (2) The Lower Northern Division extends from Spencer Gulf across the South Australian Highlands to the Murray, at the Irrigation Settlement of Renmark. Its chief town is Port Pirie, where are the smelting works of the Broken Hill Mines; it also includes the Wallaroo and Moonta copper fields.

(3) The Upper Northern Division occupies the northernmost part of the Counties. Its chief town is Port Augusta, and it includes much pastoral country, with a rainfall of from 12 to 14 inches, with some wheat districts behind the Flinders Range. (4) The South-

Photo. *J. W. Gregory.*

OFFERING CAMELS WATER AT A SALT WATER POOL ON THE DIAMANTINA RIVER, SOUTH AUSTRALIA.

eastern Division is to the east and south of the Murray, and comprises some ten millions of acres, and has a rainfall of from 20 to 30 inches. Most of it is used for grazing, but around the chief town, Mount Gambier, the fertile volcanic soils produce rich crops of potatoes, and there are good dairy farms. (5) The Western Division

includes the coastal areas of the Eyria Peninsula, and is at present occupied only for pastoral purposes. The interior of this district contains large areas covered with mallee scrub (*Eucalyptus dumosa*).

South Australia is mainly dependent on its pastoral industry, as the vast arid plains of the interior can only be used for grazing; and communication across the waterless plains is often possible only by camel trains. Agricultural work is confined to the south-east and to the irrigation settlement along the Murray. The large runs in the interior support cattle, which are driven in large mobs to the southern markets. Sheep are reared mainly in the northern parts of the Counties, and the number in 1903 was 5,350,258, yielding 46,066,517 lbs. of wool. The number of cattle in South Australia in the year ending 1903 was 536,580, and 192,411 horses. The dairy produce for 1903 included 5,995,756 lbs. of butter and 941,000 lbs. of cheese. The extent of land under cultivation for the season 1903-4 was 2,256,824 acres, the gross produce of which was—

Wheat . .	13,209,465 bushels.
Oats . .	902,936 ,,
Barley . .	487,920 ,,
Potatoes .	31,415 tons from 8616 acres.
Hay . .	479,723 ,,
Vineyards .	22,617 acres, producing 2,345,270 gallons of wine.
Raisins .	13,063 cwt.
Currants .	10,406 ,,

There were 17,000 beehives, producing honey and beeswax to the value of £4500.

South Australia has very limited forests, but 182,074 acres are reserved as state forests and plantations.

The South Australian mines are of less value than those of any other State in Australasia. Historically

they are important, as the copper mines of Moonta, Burra-burra, and Wallaroo first established the prosperity of the State. Copper is the chief metal raised. The exports of silver and lead are derived from the mines in New South Wales, and are only transmitted through South Australia. Coal occurs in a small field at Leigh's Creek, and it was passed through in the bore at Lake Phillipson, to the south-west of Lake Eyre. But the coal in both cases is of inferior quality and does not pay to mine. Accordingly the working of the South Australian railways in the interior is expensive owing to the high cost of coal.

Gold is found in small mines in the northern part of the South Australian Highlands; at Tarcoola to the west of Lake Torrens; and also in the Arltunga goldfield of the Northern Territory, where tin and other minerals have also been found.

The chief exports for the year 1903 were as follows:—

Wool	£1,239,744
Wheat	744,680
Hay and chaff	481,404
Copper	388,162
Skins and hide	292,093
Live animals	162,642
Wine	124,916
Meat	114,400
Bark	68,850
Gold	24,828
Butter	23,230

The total imports amounted to £6,743,872, and the total exports to £8,490,359.

The only important fishery is for pearl and pearl-shell from Port Darwin in the North Territory. The South Australian boats engaged in this trade in 1902

obtained 126 tons of pearl-shell, to the value of £21,398.

Manufactures in the State are of minor importance. The number of factories in 1903 was 1339, and the number of hands employed at them, 18,644.

The railways open at the end of 1904 include a length of 1736 miles, which have been built at a cost for construction and equipment of £13,517,727, the average cost of construction being £7785 per mile. The chief railway is that which goes from the Victoria frontier at Serviceton, crosses the south-eastern desert and the Murray at Murray Bridge, and then goes over the Mount Lofty Range, past Mount Barker, to Adelaide. A branch from this railway at Bordertown goes southward to Mount Gambier and the agricultural districts in the extreme southern corner of the State. Secondary railways run from Adelaide to the north-west bend of the Murray at Morgan and to Port Elliot, on Encounter Bay, west of the mouth of the Murray.

The longest railway is that which runs from Adelaide across the South Australian Highlands to Quorn, whence a branch line descends through the Pichi-richi Pass to Port Augusta. From Quorn the Great Northern Railway continues to Hergott, whence, after passing to the south of Lake Eyre, it continues north-westward to Oodnadatta. This line was intended to cross the whole continent, to join the line which runs for 149 miles inland from Palmerston to Pine Creek. Branches from the northern railway run eastward through Cockburn to Broken Hill, and westward to Port Pirie on Spencer Gulf, to Port Wakefield at the head of the Gulf of S. Vincent, and to the copper-mining districts of Wallaroo and Moonta, at the northern end of the Yorke Peninsula. The Melbourne Railway is on the gauge of 5′ 3″, the

Great Northern Railway and its branches are on the gauge of 3′ 6″.

5. Political Geography

The population, according to the census of 1901, is 358,508 in South Australia proper, and 4096 in the Northern Territory. These numbers exclude the 27,123 aborigines, an increase of 3334 over the number recorded by the census of 1891. The estimated population at the end of 1903, excluding aborigines, is 365,565. The aborigines have been reduced in numbers by disease and decreasing birth-rate, except in the Northern Territory. They are under a Protector, and there are four aboriginal reserves: one is at Kopperamanna and Kilalpaninna, to the east of Lake Eyre; one at Hermansburg, in the Macdonnell Ranges; one at Point Pearce, in Yorke Peninsula; and the fourth on Lake Alexandrina, at Point Macleay. At the last station it is interesting to note that during the last three years there has been, among the aborigines, a slight excess of births over deaths.

The Government of South Australia consists of a Governor appointed by the Crown, an Executive Council, and a Parliament of two Houses. The number of members has been reduced by an Amended Constitution Act in 1901, as a corollary to the establishment of the Federal Parliament. The Legislative Council has been reduced to 18 members, and the House of Assembly to 42 members. The Legislative Councillors are elected by four districts, and five of them retire every third year. The members of the House of Assembly are elected by thirteen constituencies; the elections are triennial; but the House may be dissolved at any time by the Governor in Council. Women have votes for both chambers, and the

members of both receive £200 a year and free railway passes.

The revenue for the year ending 30th June 1903 was £2,510,955, the expenditure £2,543,185, and the debt on the 1st July 1903 was £27,828,370, with an annual interest charge of £1,041,840. Taxes include $1\frac{3}{4}$d. in the £1 on unimproved land values, to which, in the case of absentees, 20 per cent is added. There is a graduated income tax, and income from property is taxed at a higher rate than that from personal exertion. For instance, for incomes above £800 per annum, if derived from personal exertion, the tax is 7d. per £1; whereas on an income of the same amount derived from property the tax is 1s. $1\frac{1}{2}$d. in the £1.

Education in the State is compulsory, secular, and free; but, owing to the scattered nature of the population, education is perhaps less advanced than in most of the other Australian States. The chief educational institution is Adelaide University, with which is connected a large technical school known as the School of Mines. There is also an agricultural farm and college at Roseworthy, 30 miles from Adelaide.

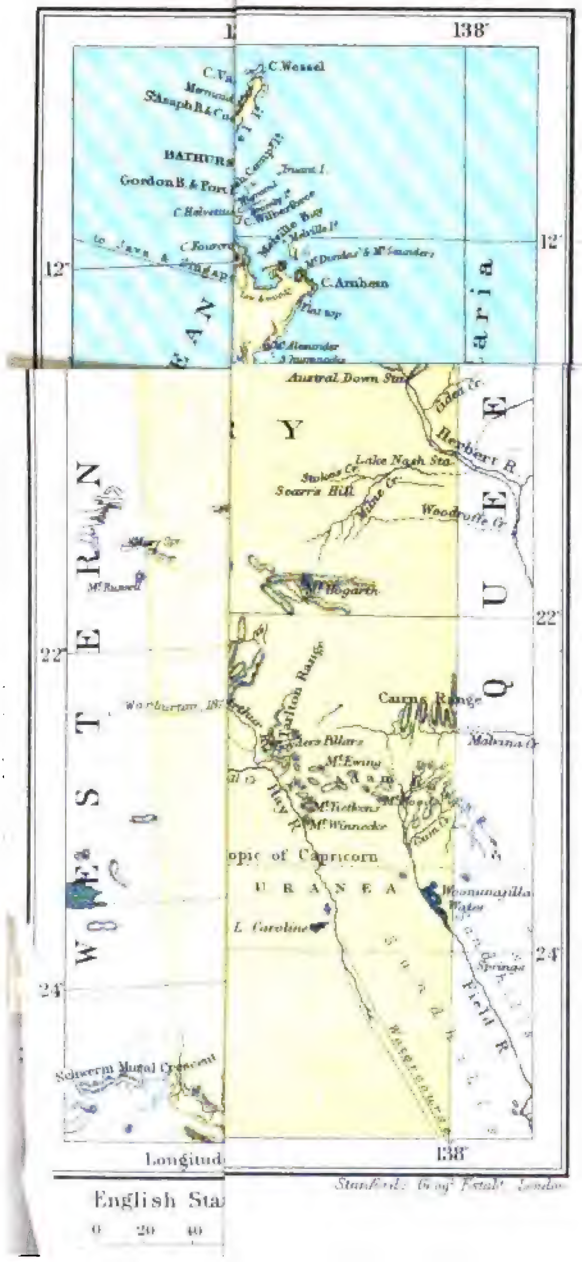
The land system differs from that in other Australian States, as legislation now favours the system of leasing land instead of its freehold sale. The largest areas leased are for pastoral purposes, and in the less accessible parts of the State the land is granted on lease for forty-two years, the rent being revalued at the end of twenty-one years. Every lessee must within three years carry out certain improvements, destroy the rabbits or other vermin, and put upon it, within three years, one head of cattle or five head of sheep per square mile. This number must be increased fourfold by the end of seven years. In the more settled districts of the State homestead blocks are

leased at an average rent of about 1s. 5d. per acre, the lessee being bound to reside on the property and to improve it; there is a reduction in the charges, if any of the land be planted as vineyard or orchard. In the Northern Territory land is let in blocks not exceeding 3000 acres; or it may be purchased at not less than 5s. per acre, or let on lease for twenty-one years, or on perpetual lease. Pastoral lands are leased at the price of 6d. per square mile for the first seven years, 1s. for the second seven years, 3s. for the third, and subsequently at a rent arranged at the end of the first twenty-one years' period.

6. Towns in South Australia

ADELAIDE (34° 57′ S. lat., 138° 38′ E. long.), the capital of South Australia, is situated on the Torrens River, 6 miles east of St. Vincent Gulf. Port Adelaide is its port. It is in direct railway communication with Melbourne, and a line runs northward to Oodnadatta, with a branch line to the mines of Broken Hill. The city has not made such rapid progress as the other Australian capitals, as the mining industry of the State has remained of secondary importance, and its agricultural development has been delayed by deficient rainfall. The Adelaide Plains end to the east at the foot of the scarp of the Mount Lofty Ranges. There are some fine public buildings, a good Picture Gallery, Library, and Museum, a University, and a Technical College called the School of Mines. In 1901 the population of the city was 38,981; and that within a ten mile radius of the Post Office was 162,094.

GAWLER (34° 39′ S. lat., 138° 45′ E. long., 176 feet above sea-level), at the junction of the north and south Para River, 25 miles north-eastward of Adelaide, is a



C. Wessel
BATHURST
Gordon B. & Port
Melville Bay
C. Arnhem
Austral Down Sta
Herbert R.
Lake Nash Sta.
Stokes Cr.
Scarr's Hill
Woodroffe Cr.
Hogarth
Cairns Range
Mt Ewing
Mt Winnecke
Tropic of Capricorn
URANEA
L. Caroline
Springs
Schwerin Mural Crescent
Longitude
Stanford's Geog! Estab! London
English Sta
0 20 40
12°
22°
24°
138°

railway junction on the northern railway. The district is mainly agricultural, but ores of silver, copper, lead, and gold occur in the neighbouring hills. The population of the town is 3200, and of the district 7000.

LYRUP (34° 25′ S. lat., 139° 10′ E. long.), a small town on the Murray, 255 miles north-north-east of Adelaide, reached by rail from Morgan, thence by steamer or coach. It is in the centre of a rich agricultural district, producing butter, cheese, bacon, potatoes, onions, vegetables, wheat, wool, raisins, dried apricots and peaches. Population of the town 112; of the district 5000.

MOONTA (34° 5′ S. lat., 137° 36′ E. long.), on the shores of Moonta Bay, on Spencer Gulf, 102 miles north-west of Adelaide (134½ miles distant by rail), is a mining town which has worked copper since its discovery in 1861. The chief yield is from the Moonta Mine. The population of the town is 1700; of the district 7000.

MOUNT BARKER (35° 5′ S. lat., 138° 58′ E. long., 1050 feet above sea-level) is the chief township on the old plateau of the Mount Lofty Ranges. It is at the foot of Mount Barker, 22 miles east of Adelaide. It is in an agricultural district, with large orchards and vineyards. The population of the town is 2000; that of the district, within a thirty mile radius, is 34,000.

MOUNT GAMBIER (37° 50′ S. lat., 140° 50′ E. long.) is the chief town in the south-eastern corner of South Australia, and is 305 miles south-eastward of Adelaide. It is situated at the northern base of the remarkable extinct volcano, Mount Gambier. The district is agricultural. The population of the district is 8000.

OODNADATTA (27° 15′ S. lat., 135° 18′ E. long.), the northern terminus of the Great Northern Railway, 688 miles from Adelaide.

PORT AUGUSTA (32° 30′ S. lat., 137° 46′ E. long.) is

the port at the head of Spencer Gulf. It exports the wheat and wool from the Highlands to the east, and of the plains of the Lake Eyre basin, to which it is connected by the Great Northern Railway. There are ostrich farms on the sandy plains to the north of the town, at the foot of the Flinders Range. Population 2340.

PORT PIRIE (33° 10½′ S. lat., 138° 1′ E. long.), on Germein Bay, 154 miles north of Adelaide, is the port of Broken Hill, and has the large smelting works of the Broken Hill Proprietary Mine. The population of the town and district is 11,000.

7. Town in the Northern Territory

PALMERSTON (12° 27′ 45″ S. lat., 130° 50′ 45″ E. long.), on the eastern side of the fine harbour of Port Darwin, is the chief town in the Northern Territory. It stands on a peninsula, which divides the main portion of the harbour from Fannie Bay. It is about 2000 miles north-north-west of Adelaide, to which the usual communication is by sea. A railway line goes inland to Pine Creek, and was intended to connect with the line northward from Adelaide, which now ends at Oodnadatta. The population is: Europeans about 1500; Chinese and other Asiatics 2800; Aborigines 20,000.

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CHAPTER XVI

WESTRALIA

West Australia, or Westralia, occupies the western third of Australia, and is by far the largest of the States. It includes almost the first part of Australia visited by Europeans, for in 1616 Dirk Hartog visited Shark Bay, leaving there a record, which has recently been discovered in the Riks Museum of Amsterdam. The State, moreover, received British colonists earlier than Queensland, South Australia, or Victoria. Nevertheless Westralia, in spite of its size, its comparative age, and its closer proximity to Europe, has the smallest population of any State on the mainland of Australia, and in 1891 the census recorded only 49,782 inhabitants.

Westralia is bounded to the north and west by the Indian Ocean, and to the south by the Southern Ocean. It is separated from South Australia by vast stretches of desert, crossed by an artificial frontier along the 129th meridian.

The area of Westralia is 975,920 square miles, or 624,588,800 acres. It is therefore a little more than eight times the area of the United Kingdom.

The coast line is comparatively short, being only about 5200 miles long; for its course is regular with open curves; it is deeply indented only in Tasman Land,

north of the parallel of 18°, where there are deep gulfs, long peninsulas, and archipelagoes.

The length of the State from north to south is 1480 miles, and from east to west about 1000 miles.

1. The Colonisation of Westralia

The colonisation of Westralia was begun in 1827, by an expedition under Captain James Stirling, sent from Sydney by Governor Darling. Its object was to examine the country in the neighbourhood of the "Black Swan River," which had been thus named by de Vlaming in 1696, because of his discovery of black swans there. Stirling's expedition explored the Swan River, and made the ascent of the western face of the great inland plateau, which was called the Darling Hills. Stirling gave a very glowing account of the country, being impressed by the richness of the soil, the ease with which the ground could be cleared, the abundance of fresh water, and the accessibility from the sea. Accordingly, in 1829, a vessel was sent to Western Australia to proclaim it as British, and possession was claimed "of all that part of New Holland which is not included within the territory of New South Wales." A month later Stirling arrived in the *Parmelia* with a party of settlers, numbering sixty-nine in all, to establish a colony, of which he had been appointed Lieutenant-Governor. Stirling founded the city of Perth about twelve miles up the Swan River, leaving a minor station at the mouth of the river. The first stone of the city of Perth was laid on the 12th of August; the land regulations were proclaimed on the 28th of August; grants of land to the extent of 69,771 acres were issued a month later, and in November of the same year, 1829, an effort was made to explore the

interior. Next year settlements were established in other parts of Westralia; the most important were King George's Sound, which had formerly been occupied by seal and whale fishers, and those at Guildford and Augusta. The Swan River Settlement was used as a convict station, and the last consignment arrived in the *Hougoumont* in 1868.

The first of the many deplorable conflicts with the aborigines occurred in November 1830. A black fellow was killed during an attempted robbery; the aborigines, in accordance with their custom of retaliation, murdered a white man, and a blood feud began. Serious conflicts occurred in 1835 and 1837, followed by a guerilla warfare. As stations were established in the back country, occasional isolated murders and reprisals were inevitable, until the aborigines learnt to appreciate the white man's view of sheep stealing; but as the country became opened and the aborigines and white men learnt to know each other, more satisfactory relations were established.

The young colony at first made steady progress, but it was very slow. In 1831, 160 acres of wheat were reaped, and the country was proved capable of yielding good grain crops. The first vineyard was established in 1832 at Hamilton Hill, and in 1834 the wool trade began with a shipment of a small parcel of 7585 lbs.

The great timber resources of the colony were first utilised by a shipment of sandalwood in 1845; the export of horses to India was begun in 1844, and that of guano from the Abrolhos Islands in 1847. The discoveries of the mineral wealth of the colony began in 1846, when coal was reported on the Murray River. In 1848 Gregory discovered ores of copper and lead, in the Northampton Mining Field, behind Champion Bay.

The first smelting furnace was established in 1852, and the export of lead began the following year. The presence of gold in Westralia was first proved in 1848, in some ores collected by A. C. Gregory; and the next noteworthy find was by the same geologist on the Bowes River, in the Murchison district, in 1854. Gold was subsequently found in many scattered localities, in small quantities; but in spite of repeated search none of the discoveries were of economic importance.

In 1862 the Government engaged E. H. Hargraves, the discoverer of the New South Wales Goldfields, to inspect the colony; but his opinion was not favourable, as is shown in the title of his paper, published in 1864, "On the Non-Auriferous Character of the Rocks of West Australia."[1]

The occurrence of sufficient gold in any one district to justify the proclamation of a goldfield was not known until 1886; then the search in the Kimberley district, inspired by Hardman's favourable opinion as to its prospects, was rewarded by success, and the Kimberley Goldfield was proclaimed on the 19th May 1886.

2. Geographical Structure

The State consists in the main of a vast plateau of Archean rocks, which appears never to have been below sea-level throughout the whole length of geological time. The western face of this plateau may be seen rising some twenty miles back from the coast near Perth. The ascent to it is fairly steep, and from its western edge it continues inland as a broad undulating plateau, mostly between 1000 and 2000 feet in height, till it crosses the South Australian border. The Archean plateau

[1] E. H. Hargraves, *Proc. Roy. Geogr. Soc.* viii. pp. 32-34, 1864.

reaches the southern coast at Point d'Entrecasteaux near the south-western corner of Australia. But further eastward it sweeps inland, and is separated from the coast by a belt of low-lying sandy country, and still farther east by the broad limestone Nullabor Plains. To the north the boundary of the Archean plateau is at present not well defined. It appears to reach the coast at Pilbarra, and passes to the south of the Kimberley district, which is occupied by mountain chains, built of sedimentary rocks of later age, which run from north-west to south-east.

The surface of the main plateau of Westralia is gently undulating, and it has comparatively few conspicuous peaks. The best known mountain lines are the scarps of the plateau, which rise above the coastal plains. The best known is the Darling Range, which runs, north and south, across the whole southern half of the State, at a distance of generally from 18 to 20 miles from the coast. Near its southern end this scarp is farther inland, as the Leeuwin Peninsula is a projecting off-lier from the Darling Range, which reaches the southern coast at Point d'Entrecasteaux. The highest point of the Darling Range, Mount William, is about 1700 feet high. The Stirling Range is the western end of the southern scarp of the plateau. It rises in Bluff Knoll to the height of 3640 feet. Farther east is the Russell Range, between Esperance Bay and Israelite Bay; then the plateau sweeps north-eastward round the Nullabor limestones and the plains of the Great Victoria Desert, which extend inland behind the Great Australian Bight. In the north the Hammersley Range of Pilbarra also appears to belong to the great plateau, which rises in Mount Bruce to a height of 3800 feet, the highest point in the State. The mountain system of the Kimberley district

has better defined mountain ranges. They belong to the series of mountains composed of Lower Palæozoic rocks, running north-west and south-east, of which the broken remnants can be found at intervals across Central Australia. The indentations on the coast of Tasman Land occur where these mountain lines project out to sea. Thus the Princess May Range projects north-westwards beside York Sound; its highest point, Mount York, is probably over 3000 feet; but the highest adequately determined height in Kimberley is Mount Hann, 2800 feet.

The characters of the main plateau of Westralia are monotonous. Most of it rises between 1000 and 2000 feet above sea-level. The surface is gently undulating, the hills being low and well rounded, and the intervening valleys broad and shallow. These features are the natural outcome of the low rainfall and high temperatures. Its rain is lost by evaporation, and it is only near the edge of the plateau that there is any discharge through rivers to the lowlands and the sea.

Owing to the absence of rivers no deep valleys have been cut backward into the plateau. The material from the hills is carried by winds and rain on to the lower ground and there deposited. The valleys are thus gradually filled up, and the lower slopes of the hills are buried under piles of rock debris, while wind erosion rounds off the summits. But below the thick sheets of wind-blown drift on the floors of the valleys and lake basins there are, as at Kanowna, beds of gravel, which indicate more powerful river action in former times. The rain that flows down the slopes collects in basins, from which the water is gradually lost by evaporation. At times these basins have wide, shallow sheets of brine, the salts having been obtained from the rocks of the

adjacent hills. When the brine is all dried up the lake beds are coated with salt, and accordingly remain bare and absolutely barren. The water in the shallow wells is mostly saturated with salt, so that it is useless unless distilled, for which fuel is not always available. Fresh water is only procurable from rain, collected off the surface of the rounded domes of granite. The bases of these hills near European settlements are surrounded by trenches, which guide the water into tanks. Such a supply is inadequate for mining camps and large cities, which have been dependent on distilled water, costing from one shilling to two shillings per gallon. The mining fields of Coolgardie and Kalgoorlie are supplied by a water pipe, 350 miles long, from a reservoir in the coast lands behind Perth, whence it is pumped over the face of the Darling Scarp on to the plateau, and thence over the plateau to the mining centres.

The vegetation on the plateau is sparse, and consists of species adapted to desert conditions. The chief trees are acacias, banksias, sheoak (*Casuarina*), desert gums, sandalwood (*Santalum*), etc. They generally occur in sufficient abundance to supply the miners with timber and fuel, though some of the mines have to lay timber lines for 50 miles into the bush. The ground between the trees and on the treeless plains is generally occupied by scattered tufts of wire grasses, herbs, and salt bush, which forms the best available forage. But in spring, after the rains, the plains are covered with a carpet of flowers, which for the beauty of their brilliant sheets of colour are, perhaps, unrivalled in any moorland vegetation in the world.

3. The Rivers

West Australia is badly provided with rivers, as the whole of the great central plateau is an area of interior drainage, and does not send a single permanent river to the coast. Most of the rivers are short, as they only carry the rainfall on the scarp of the plateau across the coastal plains to the sea. On the southern coast the rivers are insignificant, the chief being the Phillips River and the Pallinup, and the Blackwood River in the Leeuwin Peninsula. The chief river in the southern part of the western coast is the Swan River, which passes Perth and discharges into the sea at Freemantle. Further north is the Greenough River, which enters the sea to the south of Geraldton. The two chief rivers on the western coast are the Murchison and the Gascoyne, both of which have somewhat longer courses, as they rise well back on the central plateau. The Murchison drains the southern part of the Western Division of the State, including the Murchison Goldfield; while its tributary the Sandford comes from the northern part of the Yalgoo Goldfield. The Murchison reaches the sea at Gantheaume Bay, but it only flows in floods, and usually consists of a chain of water holes. The northern part of the Western District is drained by the Gascoyne, which rises in the Peak Hill Goldfield and flows into Shark Bay at Carnarvon. The north-western coast is drained by three rivers—the Ashburton, which rises in the Ashburton Goldfield, and reaches the sea at Onslow; further east is the Fortescue, and then follows the de Grey, of which the chief tributary is the Shaw, while its upper part is known as the Oakover. The Fortescue and de Grey Rivers cross the Pilbarra Goldfield. In the Kimberley district, owing to better rainfall, there are larger rivers, including the

Prince Regent and the Fitzroy on the north-west, and the Ord and the Pentecost on the north-east.

4. The Land Divisions

Westralia is divided into six land divisions, which correspond with natural divisions of the country, though the boundaries between them are indefinite. The Kimberley Division in the north has an area of 144,000 square miles, and has an average rainfall of about 25 inches. It includes the Kimberley Goldfield, and much land with rich soil and excellent pastoral country.

The North-Western Division has an area of 81,000 square miles, and an average rainfall of about 10 inches. It has better rivers than any of the country further south, and they have cut deep valleys, separated by bold ranges and belts of plateau, on which the ground is often sandy and covered with spinifex. The best of it is estimated as able to support half a sheep to the acre.

The Western Division comprises 133,000 square miles, and includes the basins of the Gascoyne and the Murchison Rivers. The interior includes the Gascoyne, the Peak Hill, the Ashburton, the Murchison, and the Yalgoo Goldfields. The lowlands to the west consist of sandstone coastal plains, which have a better rainfall. The average rainfall for the whole division is about 8 inches.

The South-Western Division includes the most temperate and the best populated part of the State. Its area is 77,850 square miles, and it includes all the fertile coast-plains from Geraldton to Geographe Bay, and along the southern coast as far as Israelite Bay. It thus includes all the rich forests of the south-western corner of Australia, which yield valuable supplies of

Jarrah and Karri timber. It also includes the Collie Coalfield, the Greenbushes Tinfield, and the chief grain-growing districts of the State. Its eastern port, on Esperance Bay, is 126 miles from the southern end of the mining fields of Dundas and Norseman, so that it offers the shortest railway route to the eastern goldfields.

The remainder of the southern coast is in the Eucla Division, which includes 48,000 square miles, most of which is a limestone plateau with good forage, but without permanent water. Except for a strip along the coast which is well supplied with springs, this district is practically uninhabited.

The Eastern Division includes nearly 500,000 square miles of the great Western Plateau of Australia, and the deserts in the eastern part of the State. It remained unoccupied until the development of the goldfields, from which pastoral occupation is gradually spreading.

5. Geology of Westralia

The structure of Westralia[1] appears simpler than that of the other States. This feature may be due; to some extent, to our less knowledge of its geology. The State occupies the whole western half of Australia, but it has a smaller population than any other State on the mainland, and, owing to the long stretches of waterless country, travel within it is arduous and difficult. Hence, in spite of the magnificent work already accomplished by

[1] An excellent summary of the Geological Structure of Westralia is given by Gibb Maitland, the Government Geologist, in his "The Mineral Wealth of Western Australia," *Bull. Geol. Surv. W.A.* No. 4, 1900, pp. 7-23. It is reprinted in the Year-Book of Western Australia, issued periodically.

A bibliography of the Geology of Western Australia, by Maitland, was issued in Bulletin No. 1, 1898, 31 pp.

the Westralian Geological Survey, large parts of the country are still imperfectly known.

The main mass of Westralia consists of a block of Archean rocks, forming a high tableland, which rises with steep scarps above the coastal districts, that form a girdle round it on the north, west, and south. The Archean plateau passes eastward into that of Central Australia. No marine deposits are yet known upon the surface of this tableland, though they occur on all sides at its feet, and appear to creep up its flanks along former valleys or arms of the sea. The Archean rocks are frequently covered by broad sheets of Cainozoic silts and sands; but these sediments all appear to be the result of subærial accumulation, in places assorted by rain and streams. Pioneer geological surveys have been made across all the principal districts of Westralia; so it may be doubted whether marine rocks exist in the interior. Hence it appears probable that Westralia consists of a great Archean block or coign, which has never been below the level of the sea; though time after time the sea has washed its borders. This old Archean block is bounded to the south by the coastal districts with Cainozoic marine deposits, along the Great Australian Bight, and by the supposed Silurian rocks of the Stirling Range. It is bounded to the west by the scarp known as the Darling Range, and to the north by the Palæozoic rocks of the Hammersley Range, between the Ashburton and Fortescue Rivers, and of the Pilbarra and Kimberley Goldfields. To the east the Archean plateau ends against the Cretaceous basin and Palæozoic ranges of South Australia, which sweep, from the Termination Range near Hergott, through the Peak and Macdonnell Ranges to the Kimberley Goldfield. How far the Palæozoic rocks extend to the westward is not yet known.

The main interest in the Archean plateau centres in its mineral wealth, as in it occur all the goldfields of Westralia. The Archean rocks are best known in the western part of the State, along the railway line between Perth and Kalgoorlie; and they occur in the same general sequence in other traverses across the State from east to west. The bulk of the Archean rocks is made up of gneisses, schists, and granites; the Plutonic rocks have generally been foliated; there are occasional beds of clay-slate and quartzites.

The Archean rocks are described by H. P. Woodward as occurring in six parallel belts, running northward and southward across Westralia, with, on the whole, a slight trend to the north-west. Their course becomes more irregular to the north. The first belt forms the base of the coastal district all along the western coast, from the Murchison River southward to Cape Leeuwin. Most of this belt is covered by later deposits; but the Archean are exposed at intervals, as in the copper mining-field of Northampton and in the Cape Leeuwin Peninsula. These rocks are the least altered of the series. They consist of clay-slates and quartzites, interbedded with some schists, and traversed by dykes of diorite and granite. The second belt is exposed in the scarp that forms the western face of the plateau. This scarp is known as the Darling Range, and looks like a mountain range when seen from Perth; but when the summit is reached it is found to be only the edge of a plateau, which extends inland, at a height varying generally from 1600 to 1400 feet, into the central deserts. The Darling Scarp or Range is known by different names in various parts of its course. It is called the Victoria Range in the north, between the Murchison and the Gascoyne Rivers.

The rocks of the second belt are gneisses and schists

traversed by dykes of porphyrite, diorite, granite, and felstone. Amongst other mineral deposits, it yields tin, in the Greenbushes Tinfield; veins of mica and asbestos; and a deposit of graphite near Bridgeton.

The third belt extends from the southern coast to the Murchison River, and is about 100 miles wide. It is known as the first granite belt, because it is composed of various granitic rocks. The country is mostly barren of water, and quite bare of minerals; hence it long remained an effective barrier to settlement spreading eastward from the coast. The granite is traversed by numerous dykes, and includes bands of schists and gneisses, which probably represent crushed igneous rocks. The main rock is called granite; but it is foliated and is a gneiss.

The fourth belt is the first auriferous belt, and is about 100 miles in width. It begins at the Phillips River on the southern coast, and extends northward through the Ravensthorpe Range and Southern Cross, on the Perth and Kalgoorlie Railway; thence it bends westward past Mount Magnet on the Northern Railway, and continues northward across Lake Austin to Cue; thence it bends north-eastward through the Murchison Goldfield to Nannine, and then northward through the Peak Goldfield and the Robinson Range, and past the heads of the Gascoyne and Ashburton Rivers. To the north of the Gascoyne and Ashburton Goldfields, this auriferous belt sinks beneath the Palæozoic rocks of the plateau between the Ashburton and Fortescue Rivers.

The fifth belt is known as the second granite belt, as it is composed of granite and gneisses; it is about 100 miles in width; it occurs on the southern coast to the east of the Phillips River; it follows the first auriferous belt northward across the State, until it dips between the Palæozoic plateau of the Fortescue.

The sixth belt, or second auriferous belt, is the easternmost of the series. It begins near the southern coast, in the Dundas Hills, to the north of Esperance Bay; it trends thence through the Dundas Goldfield, past the mining centres of Norseman and Lake Cowan, to the goldfields of Coolgardie and Kalgoorlie, and continues thence through Lake Carey and the Mount Margaret Goldfield. It reappears behind the north-western coast in the Pilbara Goldfield. The rocks of both auriferous belts consist in the main of schists, of which the most important is a series of amphibolites, and there are numerous dykes of granite, diorite, and porphyrite. Bands of the amphibolites have been so crushed that they often resemble altered slates, and others have been silicified into jasperoid, and mineralised into the rich lodes of the Kalgoorlie Goldfield.

The coastal districts of Westralia lie at the foot of the Archean plateau, and contain a long series of marine sedimentary rocks. Probably when they are fully known they will prove to contain representatives of most of the geological systems. The most interesting Palæozoic area yet known in Westralia is the tableland of the Kimberley district and Kimberley Goldfield, in the extreme north-east of the State. The foundation of this plateau consists of Cambrian rocks, which strike from north-west to south-east. To the west and south-west of the Cambrian rocks is a belt of slates and quartzites, which strike from north-west to south-east, parallel to the Cambrians. These rocks are provisionally accepted as Silurian, but no fossils have been found in them. They are covered unconformably by a series of sandstones and conglomerates, which are identified as of Devonian age ; and the Kimberley plateau is fringed by a belt of Carboniferous rocks, which sweep round its southern and eastern margins,

from Roebuck Bay on the west, to the South Australian frontier, near Windsor, to the east of Cambridge Gulf.

The Cambrian rocks are exposed from beneath the Carboniferous deposits in the Kimberley Goldfield. The Cambrian rocks are a series of shales, quartzites, and sandstones, and probably underlie most of the goldfield. They outcrop from the Burt Range on the north-east, to Mount Dockeril in the south. Though they range from north-east to south-west, the strike of the strata and the axes of the folds run from north-west to south-east. The age of these rocks is proved by the fact that they contain worms of the genus *Salterella*, and a trilobite, which is referred to the genus *Olonellus*, under the name of *O. forresti*. The first payable goldfield discovered in Westralia is situated on these rocks.

The Silurian system is doubtfully represented in two districts. To the west of the Cambrian area of Kimberley occurs a belt of quartzites, grits, and conglomerates, interbedded with beds of sandstone and purple slate. They strike from north-west to south-east, parallel to the Leopold Range. The second area of rocks, supposed to be Silurian, occurs in the south of Westralia, in the Stirling Range, north of Albany. These rocks are unfossiliferous quartzites and shales, which, according to H. P. Woodward, have been thrown into three sharp folds by thrusts from the south.

The Devonian system is well developed in the Kimberley district, where the rocks occupy an area of about 2000 square miles, and are estimated to be 10,000 feet in thickness. Their age is clearly proved by their abundant fossils. The sedimentary rocks are associated with a series of interbedded basic lavas and volcanic ashes.

The Carboniferous rocks of Westralia belong, in the

main, to the marine limestone type of the Lower Carboniferous. The upper or terrestrial type of the Carboniferous is less well developed. Both divisions occur in the Kimberley district, where the Lower, or Limestone series is well shown between the Fitzroy River and the supposed Silurian rocks of the Leopold and Mueller Ranges. The Lower Carboniferous limestones form a series of hills, running from north-west to south-east, through the Napier, Oscar, and Geikie Ranges. The beds have a dip of as much as 25°. Further eastward, the series is developed in the area known as the Rough Range or Haughton Range; it continues past Mount Huxley, turns north-eastward, and, passing between the end of the Silurian rocks of the Leopold Range and the Cambrian rocks of the Kimberley Goldfield, reaches the Margaret River, which flows into the southern end of Cambridge Gulf. A series of Lower Carboniferous limestones is exposed in the Ord River district, to the south-east of the Cambridge Gulf. The upper division is represented by the Carboniferous sandstones, which extend from Roebuck Bay on the west, south-eastward along the southern side of the Fitzroy River, and through the St. George's Range; thence they continue westward, and turn north-eastward, and, passing through the Hardman Range and the Ord Range, appear to cross the frontier into the Northern Territory of South Australia. These Upper Carboniferous beds of the border of the Kimberley Tableland, on the south of the Oscar and Geikie Ranges, have a high dip, whereas those in the interior of the area are nearly horizontal.

The Carboniferous limestone beds are also well developed in the basin of the Gascoyne River, where they are rich in fossil corals. Beneath the Carboniferous limestones are shales and conglomerates, and beds con-

taining coarse boulders. That some of these boulders are of glacial origin is clearly shown in the excellent photographic illustrations published by Mr. Gibb Maitland;[1] the Carboniferous glacial beds were traced by him for over 60 miles between the Wooramel and Minilya Rivers.

The Irwin River contains the third chief outcrop of the Carboniferous beds, which were first noted by A. C. Gregory in 1846, and were traced by von Sommer for 160 miles from the Irwin to the Moore River. The Carboniferous rocks of this area are bounded to the south and the east by the Archean rocks; and they disappear to the west beneath the sandy plains of the coastal district.

The presence of Carboniferous land deposits at Kimberley is indicated by the presence of Lepidodendron and some plants identified as Stigmaria. But no coals have yet been discovered there.

The Irwin Coalfield appears, however, to be of undoubted Permo-Carboniferous age, as is shown by the fossils associated with the coal deposits, such as[2]—

Productus subquadratus.
Cyrtina carbonaria.
Aviculopecten subquinquelineatus.

An analysis of the coal is given by Maitland as follows:—

	Per Cent.
Moisture	2·66
Volatile hydrocarbons	29·68
Fixed carbon	52·92
Ash	14·74
	100
Its calorific value in British thermal units is	11·959

[1] A. Gibb Maitland, "Ann. Prog. Rep.," *Geol. Surv. Western Australia for 1900* (1901), p. 28, Pl. iii. iv.

[2] A. Gibb Maitland, *Rep. Dept. Mines, Western Australia, for 1903* (1904), p. 136.

The Collie Coalfield to the west of Bunbury is generally regarded as Mesozoic,[1] but according to R. Etheridge,[2] jun., it is Permo-Carboniferous. The coalfield occurs in a shallow basin eroded out of the underlying Archean rocks.

An average of thirty-four analyses of the coals, given by Maitland,[3] is as follows, which shows that the coals are inferior in value to those of the Permo-Carboniferous:—

	Per Cent.
Volatile hydrocarbons	30·20
Fixed carbon	49·08
Ash	8·62
Sulphur	0·84
Moisture	11·77
Specific gravity	1·379
Calorific value in British thermal units	9·200

The Mesozoic rocks of Westralia were discovered in 1861 by F. T. Gregory,[4] and the fossils collected by him were described in 1863 by Charles Moore.[5]

The Mesozoic rocks of the coastal district consist mainly of shales, sandstones, conglomerates, and limestones, which rest in almost horizontal layers upon the older rocks. The chief outcrop of these deposits occurs along the western coast between Geraldton and Perth. In many parts of this area their presence is known only by borings, as they have been covered by Cainozoic

[1] *E.g.* by A. Gibb Maitland, "The Mineral Wealth of Western Australia," *Bull. Geol. Surv. Western Australia*, No. 4, 1900, p. 102.

[2] In *Rep. Dept. Mines, Western Australia, for 1903* (1904), p. 122.

[3] A. G. Maitland, "Ann. Prog. Rep.," *Geol. Surv. Western Australia for 1897* (1898), p. 14.

[4] F. T. Gregory, "On the Geology of a Part of Western Australia," *Quart. Journ. Geol. Soc.* vol. xvi. 1861, pp. 475-483.

[5] "Contributions to Australian Geology and Palæontology," *Rep. Brit. Assoc. for 1862* (1863), pt. ii. p. 83. See also *Quart. Journ. Geol. Soc.* vol. xxvi. 1870, pp. 226-261, Pl. x.-xviii.

deposits. They are well exposed north of Perth in the Gardner Range, and around Gingin and Yatheroo. These rocks have been proved to be over a thousand feet in thickness, and they are important in the Perth district, as when reached by bores they yield abundant water through Artesian wells. The fossils found in these rocks show that representatives of two distinct members of the Mesozoic group are represented.

Most of the fossils indicate a Lower Jurassic age, while Etheridge accepts some of the beds passed through in the Perth bores as Lower Cretaceous.

The fossils from the deep bore at Carnarvon, in Gascoyne,[1] show that the beds passed through there were as follows:—

From the surface to a depth of 1-150 feet.	Pleistocene.
„ „ 150-1238 „	In part Marine Middle Cainozoic.[2]
„ „ 1238-1406 „	Mesozoic, possibly Cretaceous.
„ „ 1406-3011 „	Carboniferous.

The second important area of the Lower Mesozoic rocks occurs in the Phillips River district, extending from Cape Riche eastward as far as Esperance Bay.

The Cainozoic rocks consist, in addition to ordinary river alluvium, sand-dunes, and raised beaches along the coast, of three main types. Along the southern and western coasts occur representatives of the ordinary marine Cainozoic beds of South Australia. They have been found by the Carnarvon bore, and are well developed around the Great Australian Bight, whence they extend

[1] A. G. Maitland, *Rep. Mines Dep. of Western Australia for 1903* (1904), pp. 150-151.

[2] The Middle Cainozoic age of these beds is stated on the evidence of specimens of Bryozoan limestones from the bore, sent to the Mines Department of Victoria.

inland for from 100 to 150 miles. This limestone country is nearly waterless, for, though it has a good rainfall, the water rapidly percolates underground, and flows seaward through channels which, when reached by bores, yield Artesian wells. The coral limestones of Shark Bay appear to be of the Middle Cainozoic age. The second type of the Cainozoic rocks are sheets of clay and sandstone, with some layers of brown coal. They are distributed in scattered localities in Westralia, as on the Gascoyne River, and the Fitzgerald River on the southern coast.

A third series of Cainozoic deposits rests on the Archean plateau of the interior; it includes vast sheets of mottled clays, ironstones, and conglomerates. In places they have been roughly assorted by running water, as in the famous "deep lead of Kanowna."[1] These clays have yielded the bones of Diprotodon, so they belong to the age of the Giant Marsupials, and may be Pliocene or early Pleistocene.

These beds contain patches of brown coal, and cement, which is sometimes rich in gold. The evaporation of water at the surface leads to the deposition of efflorescent limestones, and the ironstone known as laterite. Hills of laterite are conspicuous on the Westralian Goldfields.

Volcanic activity in Westralia has been less marked than in eastern Australia. A vast series of basic volcanic rocks occurs in the Carboniferous rocks of the Ord plateau, in the Kimberley district, and on the Fortescue River.

Basaltic rocks of Cainozoic age are known on the coast at Bunbury, where a lava flow of columnar basalt comes down to 20 feet above sea-level. This lava and

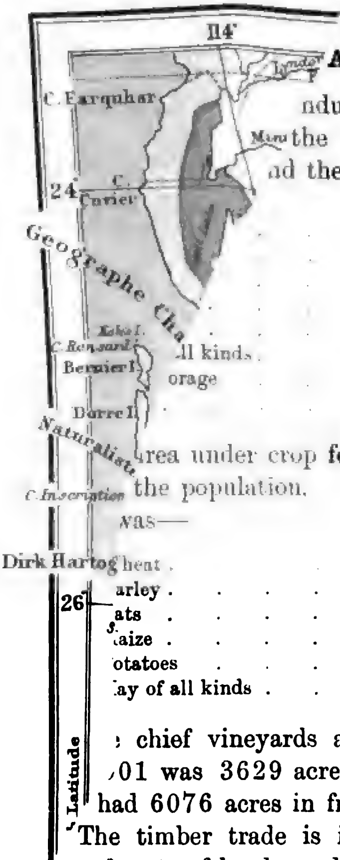
[1] See *e.g.* Blatchford, "Ann. Prog. Rep.," *Geol. Surv. Western Australia for 1897* (1898), pp. 51-52. Maitland, "Bulong Deep Leads," *ibid.* for 1900 (1901), p. 21.

that of Black Point, east of Flinders Bay, represent the Cainozoic basalts of Victoria and New South Wales.

6. Economic Geography

1. *Mining.*—The most important industry in Westralia is its gold-mining;[1] and the greatest stimulus to the development of the arid plains of the interior was given by the success of the eastern goldfields. The first step was the discovery of gold at Southern Cross in 1887, by Riseley and his party. The Murchison Goldfield was discovered in 1891. The sensational discoveries at Coolgardie by Bayley and Ford followed in 1892. The drought in the later part of 1892 prevented the immediate opening of the Coolgardie field. The town-site of Coolgardie was laid out in 1893, and it was proclaimed a township in 1894. Prospecting parties working from Coolgardie discovered, one by one, the various goldfields of central Westralia. In 1896 the Act was passed for the water-supply scheme, which supplies the mining fields of Coolgardie and Kalgoorlie. The water is collected in an artificial reservoir in the Darling Range. It is pumped, to the amount of 5,000,000 gallons a day, to a reservoir at Bulla-Bulling, 300 miles from the reservoir and 1400 feet high; thence it flows by gravitation the rest of the way. The works cost over £2,500,000. They were begun in April 1898, and the water first arrived at Kalgoorlie in January 1903. The railway to Coolgardie was opened in March 1896.

[1] A general account of Westralian mining is given by A. G. Charleton, *Gold Mining and Milling in Western Australia.* London, 1903. Also by Donald Clark, *Australian Mining and Metallurgy*, 1905. The geology of the fields is described in the reports, bulletins, and maps of the Geological Survey, under Mr. A. Gibb Maitland. A bibliography of the geology of the State was issued as Bulletin No. 1 in 1898.



Agriculture

ndustry is mainly in the south- the chief products are cereals. In ad the yield were as follows:[1]—

	Acreage.	Yield.
	94,709	956,885 bushels
	2,669	34,723 ,,
	9,751	163,653 ,,
	512	5,203 ,,
	1,829	5,739 tons
ll kinds	92,654	89,729 ,,
orage	1,563	
	3,629	

rea under crop for that year was 1·15 acres per the population. The average yield per acre[2] for was—

heat	10·1 bushels
arley	13·0 ,,
ats	16·7 ,,
aize	11·5 ,,
otatoes	3·1 tons
ay of all kinds	0·9 ,,

chief vineyards are in the south-west; the area 01 was 3629 acres; and the State in the same had 6076 acres in fruit cultivation.

The timber trade is important, Westralia possessing rge forests of hard woods valuable for railway sleepers, street paving, and harbour piles. In 1901, 62,726 loads were exported to the United Kingdom. The total amount of timber cut in the year 1901 was 122,413,000 superficial feet, and the industry employed over 3000 hands in twenty-three saw-mills.

[1] *Western Australia Year-Book for 1900-1903*, vol. ii. 1904, pp. 192, 193.

[2] *Ibid.* p. 194.

TOTAL PRODUCTION OF GOLD, IN FINE OUNCES, TO 31ST
MINES DEPARTMENT AND THE

Goldfield.	1904. December.	1904. January-November.	1904. Total.	1903.	1902.
	oz.	oz.	oz.	oz.	oz.
Kimberley . . .	17·42	188·42	205·84	627·16	297·65
Pilbarra . . .	905·58	7,124·07	8,029·65	9,602·41	10,457·86
West Pilbarra . .	11·80	3,415·91	3,427·71	5,031·09	1,910·26
Ashburton . . .	27·12	482·84	509·96	831·61	840·38
Gascoyne . . .	..	..	..	..	..
Peak Hill . . .	1,075·84	13,037·73	14,113·57	30,218·94	32,211·97
East Murchison . .	8,106·45	85,484·47	93,590·92	87,205·76	78,460·10
Murchison . . .	19,384·13	195,019·00	214,403·13	204,920·98	181,148·66
Yalgoo	136·99	2,216·42	2,353·41	3,255·93	5,029·70
Mount Margaret . .	16,146·72	167,376·53	183,523·25	180,038·22	181,573·93
North Coolgardie . .	14,101·14	130,963·47	145,064·61	165,626·14	158,981·51
Broad Arrow . .	2,056·56	20,123·63	22,180·19	25,399·18	16,906·55
North-East Coolgardie .	5,290·81	45,644·20	50,955·00	53,325·20	57,665·24
East Coolgardie . .	90,730·46	960,192·43	1,050,922·89	1,081,109·24	961,206·89
Coolgardie . . .	7,764·98	55,434·78	63,199·76	71,447·99	75,496·29
Yilgarn	1,177·42	24,331·22	25,508·64	20,014·19	19,874·94
Dundas	2,823·86	29,006·41	31,830·27	34,047·59	29,860·58
Phillips River . .	133·15	3,883·48	4,016·63	6,516·83	7,299·05
Donnybrook . . .	..	..	..	49·20	86·56
Goldfields generally . .	..	..	..	..	..
Total — Fine gold .	169,940·43	1,743,895·01	1,913,835·44	1,979,299·66	1,819,308·12
Total — Sterling value	£721,861	£7,407,595	£8,129,456	£8,407,531	£7,727,930

DECEMBER 1904, SHOWING THE QUANTITY REPORTED TO THE STERLING VALUE THEREOF

1901.	1900.	1899.	1898.	1897.	Previous to 1897.	Total to Date.
oz. 269·24	oz. 510·95	oz. 820·48	oz. 893·77	oz. 205·13	oz. 11,391·78	oz. 14,722·00
9,303·23	14,865·36	17,258·52	12,894·51	6,105·85	25,469·63	113,987·02
209·63	853·13	1,730·86	292·26	769·41	302·29	14,526·64
899·12	1,524·39	1,484·22	447·86	271·02	..	6,790·56
81·57	66·20	298·59	12·08	12·12	..	470·56
18,858·88	23,770·86	28,585·59	13,891·49	9,736·09	9,903·32	180,290·71
69,097·84	57,878·56	40,291·59	33,171·89	18,782·09	2,304·48	480,783·23
132,866·01	94,578·70	72,058·51	70,902·41	55,747·78	125,630·08	1,152,256·26
8,373·24	9,037·08	10,856·76	2,951·23	3,091·53	6,465·24	51,414·12
172,238·77	130,332·50	71,499·40	44,477·29	20,210·78	4,465·91	988,410·05
134,418·68	95,519·51	104,639·17	65,197·11	54,894·90	24,120·84	948,462·47
31,428·66	46,906·61	43,114·47	24,803·94	12,939·91	8,166·99	231,846·50
57,691·77	63,288·93	100,933·13	152,476·40	36,189·16	8,029·85	580,554·69
898,551·95	660,185·49	769,684·64	377,869·84	265,483·88	128,668·50	6,193,683·27
76,809·51	91,618·21	112,978·50	89,166·87	57,962·16	66,362·67	705,041·96
24,097·94	26,082·31	14,646·12	10,528·85	15,273·27	84,266·06	240,292·32
33,611·77	36,753·23	39,553·02	32,919·75	17,250·95	3,560·40	259,387·56
646·09	34·89	..	..	..	..	18,513·49
3·50	405·34	457·58	13·11	..	..	1,015·29
114·91	131·11	1,144·10	..	..	..	1,390·12
1,669,072·31	1,354,343·36	1,432,035·25	931,910·66	574,925·98	509,108·04	12,183,838·82
£7,089,769	£5,752,885	£6,082,899	£3,958,505	£2,442,130	£2,162,553	£51,753,658

The pastoral industry is still in its infancy. In 1901 the number of live stock was—

Horses	73,710
Cattle	398,547
Sheep	2,625,855
Pigs	61,052
Camels	1,396

The number of camels was 3984 in 1896, and 3246 in 1900.

List of Chief Exports from the State in 1902

Gold (coin)	£4,149,869
Gold	3,318,958
Timber	500,533
Wool	458,078
Pearls and pearlshells	178,699
Skins and hides	111,456
Sandalwood	61,771
Tin	39,498
Copper	12,904
Guano	4,800

The chief fishing industry of the State is for pearl and pearl shell; it dates from the discovery of pearl oysters in Shark Bay by Helpman in 1850, and now appears to be recovering from a period of depression. The chief centre of the industry is Broome; the fishery is along the north-western coast. Its extent is shown by the following table:—

District.	Vessels.		Labour.		Total Asiatic.	Quantity of Pearl Shell.		Value of Pearls.	Value of Pearl Shells.
	No.	Total Tonnage.	White.	Aboriginal.					
						Tons.	Cwts.	£	£
Broome—									
Apparatus vessels	178	2,830	87	27	1,212	643	8	26,570	88,298
Beach combing .	3	27	2	18	1	3	3	48	418
Cossack—									
Apparatus vessels	16	298	8	4	101	46	16	1,470	5,612
Onslow—									
Apparatus vessels	4	45	3	2	18	7	5	860	300
Shark Bay—									
Hand dredging .	31	130	32	14	26	130	18	1,689	940
Total . .	232	3,330	132	65	1,358	831	10	30,637	95,568

A good account of the industry was given in a Parliamentary Paper issued by the Federal Government in 1902.

8. Railways

During the 'seventies the industrial progress of the colony necessitated the development of telegraphs and railways. The Geraldton to Northampton Railway was begun in 1874, and opened in 1879. A railway line was begun from Fremantle to Guildford in 1879, and it was continued as far as Beverley in 1886; and in the latter year the line was begun to connect Beverley and Albany, and thus establish railway connection between King George's Sound and Perth.

The railways are on the gauge of $3\frac{1}{2}$ feet, and in June 1903 there were 1560 miles of State-owned lines. The Midland Line, 277 miles in length, belongs to a private company. The average cost of construction of the State lines has been £5371 a mile, the total capital cost being £8,141,782. The chief railway line runs from Fremantle and Perth to Kalgoorlie, whence a

branch goes northward, through Menzies and Leonora, to the goldfields of Mount Malcolm and Laverton. The second line is the Great Southern, which runs from Spencer's Brook, on the Kalgoorlie Line, southward to Albany. The South-Western Line runs from Perth to Bunbury, and has a branch to the Collie Goldfields and the Greenbushes Tinfield. This line serves the forests of the south-western part of the State. The Midland Line runs from Perth northward to Geraldton, whence a line goes inland to Mount Magnet, and, crossing Lake Austen, passes through the mining fields of Nannine and Cue.

9. Political Geography

The population of Westralia remained small, until the development of the mining industry. In 1891 the total population was 49,782, including 917 Chinese, but excluding the back-country aborigines. In 1901 the number had increased to 184,124, and in 1903 to 229,731, of which the males were 137,844 and the females 91,887. The population of Perth on March 30, 1901, was 66,832, of which the females numbered 30,217.

The aborigines are very scattered, and there is no reliable estimate as to their total number. In 1889 the number of aborigines in contact with the whites was estimated at over 12,000. The census of 1901 enumerated 6212, including 951 half-castes; but this number did not include the nomadic tribes in the eastern and northern parts of the State, of whom it has been maintained that the numbers are increasing.

The care of the aborigines was expressly withheld from Westralia by the Act granting it self-government,

and the aborigines remained under the care of an Aborigines' Protection Board, whose headquarters were in Perth, and which was directly responsible to the Imperial Government. This system proved a failure, and in 1897 the care of the aborigines was entrusted to the Westralian Government. The non-responsible board was abolished, and the care of the aborigines entrusted to a State Department; an Act was passed for their better protection, and the conditions of the aborigines materially improved. In 1904 the Westralian Government introduced a Bill to amend the earlier Act, in accordance with the fuller experience obtained by the authorities.

The colony of Westralia was at first governed by an Executive Council, instituted in November 1830, and composed of the Governor, the Commandant, the local Colonial Secretary, the Surveyor-General, and the Advocate-General. In 1831 the members of the Executive Council were also appointed as a Legislative Council, to which, in 1839, were added four members, nominated by the Governor. Subsequent reforms increased the number of both official and unofficial members of the Legislative Council; but the unofficial members grew most in numbers; they were semi-elective, being nominated by the districts, which the Governor appointed them to represent. By 1886 the Legislative Council had grown to nine official nominees and seventeen elected members. In 1887 the Council, by a great majority, passed a resolution in favour of the colony being granted responsible Government. A general election on this question was held in 1889, and a similar resolution was then carried unanimously.

A Constitution Bill was drafted and sent to England, where it met with considerable opposition in the House

of Commons. The opposition was mainly inspired by the objection to giving Westralia control over its extensive unoccupied Crown lands; but the Select Committee of the House of Commons, to which the Bill was referred, was convinced of the disadvantages of the continued government of Westralia as a Crown Colony, and the

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GOVERNMENT HOUSE, PERTH.

Act was passed, giving the new Parliament full control over its own lands. The Act received the Royal Assent on 15th August 1890. The Constitution appointed two Houses of Parliament: a Legislative Council, of which the members were at first nominated by the Governor, and an elected Legislative Assembly. It was provided that when the population of the colony reached 60,000, the Legislative Council should also be elective. This limit

was reached in July 1893. The Legislative Council now consists of twenty-four members, elected by eight electoral provinces. The Legislative Assembly first consisted of thirty members; the number was raised to forty-four in 1896.

In 1900, after a long conflict between the mining districts and Fremantle and Perth, a Redistribution of Seats Act was passed, by which the State was divided into ten provinces, each returning three members to the Legislative Council, and also into fifty constituencies, each returning one member to the Legislative Assembly. The Act also gave a vote for the Legislative Assembly to any natural born or naturalised British subject, who is twenty-one years of age and has resided in the State for six months.

The members of both Houses are unpaid, but they receive a free pass over the Government railways, and the private railways allow the same privilege.

The revenue of the State in 1903 was £3,545,574, mainly derived from customs, land, and railways. The expenditure in the same year was £3,679,464, and the public debt on the 31st December 1903 was £15,725,598, most of which has been expended on railways and public works.

Education, in accordance with the advanced educational programme of Australia, is free; and it is compulsory as far as is practicable with the scattered distribution of the population and the nomadic habits of the miners.

In 1902 the number of schools was 250, and there were 22,765 pupils on the rolls, the cost per head being £3 : 14 : 1. The State has at present no university, but the establishment of one is contemplated. The chief educational institutions are the High School at Perth and the School of Mines at Kalgoorlie. The education of the

aborigines is mainly conducted on the aboriginal reserves and in the Mission Stations.

The defence of the State is entrusted to a small permanent garrison and a force of volunteers. Rifle clubs are encouraged by the Government, and every member is freely supplied with 200 rounds of ammunition a year. It is thus hoped that all the men of the State will become competent to take part in its defence.

Most of Westralia is still Crown land. In December 1902, 3,570,000 acres had been sold as freeholds, and 111,000,000 acres were let on pastoral leases. Only a half of 1 per cent of the Crown lands have been ceded. A summary of the land system is given in the *Western Australian Year-Book* (1902-1903, vol. ii. pp. 165-181). Land is sold in blocks suitable for farms either on residential or non-residential conditions; and is let in large areas for sheep runs; or it is freely given in small blocks to settlers. On residential conditions, land is granted up to 1000 acres at a minimum price of ten shillings an acre, payable at the rate of sixpence an acre a year. It must be fenced in five years and ten shillings an acre must be spent in ten years; and the purchaser must reside on the land for six months in the year for the first five years, or must spend an extra ten shillings per acre on improvements. Land may be sold in blocks of the same size, without the residence conditions, in which case the full purchase price has to be paid within twelve months, and five shillings per acre must be spent in fencing and improvements. Small blocks are granted on special conditions for vineyards and orchards. Land which is infested with poisonous plants is granted at one shilling per acre, on certain conditions of residence, and the eradication of the poisonous plants. Free grants of 160 acres are made to intending settlers, who have to

pay a registration fee of £1 and satisfy some conditions as to residence, fencing, and improvements. In the back parts of the State land is granted on leasehold, for sheep or cattle runs, in blocks of 20,000 acres, at prices varying from 2s. 6d. to 10s. per thousand acres.

The following summary of the Mining Laws has been kindly supplied by Mr. H. S. King, the Secretary of Mines for the State.

In Western Australia the "Mining Act 1904" regulates almost entirely the acquisition and subsequent tenure of land for mining for gold and other minerals, and precious stones.

Under this Act land can be acquired either as claims or leases.

Claims.—To take up a claim it is necessary to be the holder of a "Miner's Right," a document issued at a fee of five shillings, which, among other privileges, confers on the holder the right—subject to regulations—to prospect on unoccupied Crown lands, and to mark out and apply for the registration of a claim.

The size of a claim is fixed by regulation, and though there is practically no limit to the size that can be fixed, as an almost invariable rule the area is small, and claims are taken up only for mining for alluvial gold or minerals, or by small parties of working miners for mining on reefs.

The term "alluvial" is defined by the Act, when applied to gold, as "any earth containing, or supposed to contain gold, and not being a lode, dyke, reef, or vein"; and when applied to mineral, as "any earth from which any mineral is ordinarily obtained by washing." "Alluvial" can only be worked in "claims," except when the ground containing it has previously been worked and abandoned, or when the alluvial deposit lies at a great

depth, or when large bodies of water are encountered, when leases may be granted.

The size of an alluvial claim for gold is an area 25 yards square for each miner; for minerals an area measuring from 300 feet square to 600 feet by 300 feet, according to locality, can be taken up; while the size of a claim for precious stones is 70 feet square.

Lode or reef claims for gold measure 25 yards by 130 yards across the line of reef, and for other minerals from 200 to 400 feet, according to locality, by 400 feet across the line of reef.

The condition of tenure of a claim is that one miner shall be regularly employed on it; but under certain circumstances a limited number of claims may be "amalgamated," in which case the same number of men are employed as before the amalgamation, but they can be employed where convenient.

Reward Claims.—Reward claims are granted for discoveries in hitherto unworked country; they are larger than ordinary claims, and it is not necessary to employ so much labour in connection with them, but they must be worked.

Leases are the most popular mining holdings, and practically all the land held for reefing is held under lease.

The extent of a gold-mining lease may not exceed 24 acres, except when it consists of abandoned alluvial ground, or deep or very wet alluvial ground, when 48 acres can be held.

The lessee of a gold-mining lease has a right to work all deposits contained by vertical planes passing through the surface boundaries.

The labour conditions of a gold-mining lease are at present two men for the first twelve months, irrespective

of the size, and subsequently one man for every six acres.

The extent of a lease for minerals other than gold, but excepting coal, may not exceed 48 acres, but 96 acres can be held when the area consists of very wet or deep alluvial ground, or abandoned alluvial ground.

The labour conditions on a mineral lease are two men for every 50 acres for the first twelve months, and one man for every 10 acres afterwards.

There is no restriction as to the number of leases a person may hold; and any number of adjoining leases may be amalgamated and worked as one, provided the aggregate area does not exceed 96 acres; but when the lode or reef deviates much from the vertical this rule is relaxed, and the owner of a number of leases is allowed to amalgamate a sufficient number of them, on the underlay side, to allow him to work the reef to a depth of 2000 feet measured on the underlay. A group of amalgamated leases must not contain more than 66 chains of the reef in the case of gold-mining leases, or 90 chains in the case of mineral leases.

The rent of a gold-mining lease is five shillings for the first year and £1 afterwards, except when the area contains abandoned alluvial ground, when the rent may be fixed at not less than five shillings or more than £1 per acre.

The rent of a mineral lease is five shillings per acre, but if it is for abandoned or deep alluvial ground, the rent may be a lesser sum, but not less than two shillings.

If gold is obtained on a mineral lease as a bye product, one shilling per ounce royalty must be paid; but if gold is the most profitable product, the lessee must convert his lease into a gold-mining lease, or pay a royalty of ten shillings per ounce.

The extent of a coal-mining lease must not exceed 320 acres, and the rent is sixpence per acre, with a royalty of threepence per ton on coal raised during the first ten years, and sixpence per acre afterwards. Two or more coal-mining leases, the property of the same lessee, may be amalgamated and worked as one mine, provided the aggregate area does not exceed 2560 acres, or when the seam is at a depth exceeding 1000 feet, 5120 acres.

The labour conditions on a coal-mining lease are one man for every 60 acres after six months from the granting of the lease, one man for every 30 acres after twelve months, and one man for every 20 acres afterwards.

The main covenants of a lease are:—

(*a*) To pay rent at the prescribed times.

(*b*) To use the land continuously for the purposes for which it is demised, and to employ the number of men prescribed by the regulations.

(*c*) A condition for the forfeiture of the lease on a breach by the lessee of any of the covenants of the lease.

(*d*) A proviso that the Governor may impose a fine of £500 as an alternative to forfeiture.

No Asiatic or African alien can hold a mining lease from the Crown.

The length of the area of a lease, as far as practicable, shall not exceed twice its breadth.

The term of any lease shall not exceed twenty-one years, but every lessee shall at the expiration of his lease have a right to renew the same for a further period of twenty-one years, subject to the Act and Regulations in force at the time of renewal.

Provisions also exist for the granting of leases to mine for gold or minerals on private land. The conditions of these leases are similar to those of leases on Crown lands, but the Act safeguards the interests of

owners of private lands, by providing for the payment of compensation for damage to the surface of the land and to any existing improvements.

If the labour conditions prescribed are found too heavy, the Minister may, on the request of the lessee, relax them, and the lessee may claim exemption from them up to twelve months, on the expenditure of certain sums fixed by the Act.

Reward leases are granted for the discovery of gold in new localities, and rent is remitted up to five years according to the locality; otherwise the conditions are similar to ordinary leases.

Areas, such as machinery, tailings, garden, business and residence areas, and water rights, for use in connection with mining, are provided for by regulation, and can be obtained on easy terms.

The safe working of mines other than coal mines is provided for by the "Mines Regulation Act 1895," and the "Coal Mines Regulation Act 1902" provides for the safe working of coal mines.

Companies carrying on business solely in Western Australia are liable, under the "Dividend Duties Act 1902," to pay a duty of 5 per cent of the amount of the dividends; companies carrying on business in Western Australia and elsewhere are liable to pay a duty of 5 per cent on the profits made in the State.

The industrial legislation is progressive, and in some respects more advanced than that of the Eastern states, as there is a Workmen's Compensation Act on similar lines to that of the United Kingdom of 1897. Most of the Acts are intended to secure healthy and safe conditions for the artisan population. The most interesting recent Act is that of the Conciliation and Arbitration

Act to settle industrial disputes without strikes. According to this Act the State is divided into three industrial districts, each of which has a Board of Conciliation composed of two representatives of the registered employers' unions and two representatives of the workmen's unions, and a chairman elected by the four representatives. Special Boards are appointed to settle any dispute that may arise. There is an appeal from the Boards of Conciliation to the Court of Arbitration, which consists of a judge of the Supreme Court, one representative of the workmen's union, and one of the employers' union.

The industrial legislation restricts the immigration of Chinese, regulates the early closing of shops, the inspection of mines, factories, and boilers, insists upon provision of seats in shops for female assistants, limits Sunday labour to absolutely necessary work, etc., and in other ways arranges for healthy and safe conditions for labour, and ample opportunities for rest and recreation.

10. Towns in Westralia

ALBANY (35° 02′ S. lat., 117° 54′ E. long.), on Princess Royal Harbour, in King George's Sound, is one of the chief seaports of the State, and a naval coaling station. The population is 3650.

BOULDER (30° 47′ S. lat., 121° 30′ E. long.), 4 miles east of Kalgoorlie, is for its size the most important mining centre in Australia. It contains the famous "Golden Mile," the richest square mile of ground yet known in mining history. Its mines include the Great Boulder, the Great Boulder Perseverance, the Golden Horseshoe, the Lake View Consols, the Oroya Brown Hill, etc. Population in the district, 20,000.

BROOME (17° 57′ 33″ S. lat., 122° 14′ 33″ E. long.)

is situated in Roebuck Bay, has an excellent harbour, and is the principal port on the north-western coast. It is the headquarters of the pearling industry. Population, including men of the fishing fleet, is nearly 600.

BUNBURY (33° 18′ S. lat., 115° 38′ E. long.), the principal port of the southern districts, is situated on the western side of the entrance to Leschenault Inlet, into which flow the Preston and Collie Rivers. A breakwater, built along a reef, protects the harbour, which is known as Koombanah Bay. It is connected by railway to Perth, and a branch line goes inland to Donnybrook and Bridgetown. Population, 300; of the district, 9000.

COOLGARDIE (30° 57′ S. lat., 121° 10′ E. long.), 118 miles east of Southern Cross, 357 miles from Perth, is historically famous as the site of the first important gold discoveries in Westralia. The finding of "Bayley's Reward" led to its proclamation as a goldfield in April 1894, and to the establishment of the mining prosperity of Westralia. The field was, however, recklessly over-capitalised, and much of the money wasted. The field has been overshadowed by Kalgoorlie, and its population has greatly declined. Population of town, 4000; of goldfield district, 15,000.

CUE (27° 25′ S. lat., 117° 52′ E. long.) is the chief centre on the Murchison Goldfield. It is 262 miles east by north of Geraldton, and 540 miles from Perth. The district is also of value for pastoral and agricultural purposes. Population of town, 1619; of district, 5000.

ESPERANCE (33° 51′ 34″ S. lat., 121° 55′ 23″ E. long.) has a large, well-sheltered harbour, with a jetty giving 23 feet of water at low tide. It is on the south coast, and is the nearest port to the goldfields, with which it is connected by a coach road. The population is about 450.

FREMANTLE (32° 3′ S. lat., 115° 45′ E. long.), at the mouth of the Swan River, is the port of Perth, from which it is 12 miles distant. There is a fine harbour and shipping accommodation along the river, and large smelting works on the shore. Population of town and suburbs, 24,000.

GERALDTON (28° 64′ S. lat., 114° 36′ E. long.) is the chief town north of Perth. It is the capital of the Victoria district, and the port for the Murchison and Yalgoo Goldfields, and the Northampton Mineral Field. It is on the western coast in Champion Bay, 306 miles north-west of Perth. The principal exports are gold, copper, lead, wool, and sandal-wood. Population of town, 2600; of district, over 6000.

GUILDFORD (31° 53′ S. lat., 116° 1′ E. long.), on the Swan River, at the confluence of Helena and Swan Rivers, is a suburban township, 9 miles north-east of Perth. Population of town, 1400; of district, 4000.

KALGOORLIE (30° 45′ S. lat., 121° 30′ E. long.), 24 miles east-north-east of Coolgardie, is the headquarters of the East Coolgardie Goldfield, and the chief mining town in Westralia. It was discovered in June 1893, by a miner named Hannan, and was at first called Hannan's. The chief mines are at Boulder City, 4 miles to the west. It is the junction of the railway lines from Perth, Menzies, Kanowna, and Boulder. Population of town, 18,000; district within 5 miles radius, 30,000.

KANOWNA (30° 37′ S. lat., 121° 37′ E. long.), a mining town, 12 miles north-east of Kalgoorlie, 392 miles from Perth, in the North-East Coolgardie district. The town is surrounded by a fair supply of timber, and a series of salt lakes occurs within 5 miles. The most famous mines are those on the Kanowna Deep Lead. Population within 5 miles, 12,500.

LAVERTON (28° 40′ S. lat., 122° 23′ E. long.) is situated on Mount Margaret Goldfield, about 630 miles from Perth. It is the mining centre for the Ida H, Lancefield, Craggiemore, and Childe Harold Mines. The population of the town is 200; of the district, 2170.

MENZIES (29° 41′ S. lat., 121° 2′ E. long.), about 466 miles north-east of Perth, is the principal centre of the North Coolgardie and Mount Magnet Goldfields. Population of the town, about 2500; of the district, within a four miles radius, 3500.

NORTHAM (31° 40′ S. lat., 116° 40′ E. long.), an important railway junction and town 57 miles north-east of Perth, on the Avon and Mortlock Rivers. The district around is mainly agricultural. Population of town, 2000; of district, 4000.

PERTH (31° 57′ 24″ S. lat., 115° 52′ 42″ E. long.), the capital of Westralia, is picturesquely situated on the Swan River, 12 miles from its mouth. The city was founded on August 12, 1829, but has received its main increase in prosperity since the discovery of the Coolgardie and Kalgoorlie Goldfields. The chief buildings are—Parliament House, the Supreme Court, the Convent and School at Highgate Hill, the Western Australian Museum, the Queen's Hall, etc. It has an agreeable climate, and is claimed as one of the pleasantest towns in Australia. The estimated population of the town and suburbs in 1904 was 49,200.

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For mining literature see p. 534; and geology, references on pp. 523, 530-533.

CHAPTER XVII

NEW ZEALAND

THE archipelago of New Zealand is included with Australia as Australasia; and at present the most striking point of resemblance between the two lands is their joint occupation by the British race. New Zealand and Australia are remarkably different in their geographical characters. Australia is a continent, and New Zealand a chain of islands. Australia is a plateau-land, with wide plains, and no long lines of recent fold-mountains. New Zealand is long and narrow, and its main geographical axes are lofty fold-mountains. The geographical features of Australia are old, and those of New Zealand young. The fauna and flora of the two countries have but little in common; and, owing to the essential difference in their geographical structure, they are strikingly unlike in their political geography. But in spite of these conspicuous differences there is an essential geographical connection between the two countries; for Australia is one of the continents which form part of the coast of the Pacific, and New Zealand is a member of one of the island festoons, which hang in loops along the continental coasts of the Pacific.

Australia is geographically somewhat monotonous, owing to the vast scale of its features, and the fact that

whatever nature gives she gives in such plenty; whereas New Zealand is unrivalled in the variety of its land forms and its geographical characters. New Zealand has an interesting combination of continental and oceanic characters. It is continental in structure, being built up mainly of sedimentary rocks, and for its size it has an exceptionally complete series of representatives of the geological systems. Its fauna and flora are in the main oceanic, as all its higher types of inhabitants have reached it across the seas. It has no native cattle, sheep, or dogs; none of the marsupials of Australia; it has neither snakes nor alligators. New Zealand has, however, among its reptiles and plants, a group of inhabitants which probably reached New Zealand when it was connected with Australia and New Guinea through the Melanesian platform.

1. Area and Position

New Zealand is an archipelago, of which the three chief islands extend from 34° 23′ S. to 47° 17′ S. There are three chief islands — North Island, South Island (sometimes called Middle Island), and the much smaller Stewart Island. The islands trend generally from south-west to north-east, to the latitude of 38°; whence the Auckland peninsula projects north-westwards, nearly at right angles to the rest of the land. The North Island has an area of 44,468 square miles, its extreme length being 515 miles and its breadth 280 miles. The South Island has an area of 58,525 square miles, its extreme length and breadth being 525 and 180 miles respectively. Stewart Island has an area of 666 square miles (425,000 acres).

In addition to these three islands, New Zealand includes the Auckland Islands, 200 miles south of

Stewart Island, with an area of 140 square miles, and the fine harbour of Port Ross; the Campbell Island, to the south-east of Auckland Island, with an area of 40 square miles; the Chatham Islands, 530 miles east of Lyttleton, with an area of 375 square miles; the Antipodes Islands and Bounty Island, to the south-south-west of the Chatham Islands, with an area together of 10 square miles. These islands are included in the New Zealand region. Beyond it, but politically included in New Zealand, are the Kermadecs, around 178° west and 30° south. Their area is 5 square miles. A proclamation of 1901 added the Cook Islands to the political dominions of New Zealand. They range from 1600 to 2300 miles north-east from Auckland. Their area is 280 square miles.

The total area of the land politically belonging to the colony of New Zealand is 104,751 square miles.

New Zealand is bounded on the west by the Tasman Sea, the easternmost sea of the Southern Ocean, and to the east, north, and south it is washed by the South Pacific. It lies on a ridge trending north-east and south-west, and the 100 fathom line around it includes the two chief islands, Stewart Island and the Snares. The 500 and the 1000 fathom lines lie close in and parallel to the south-eastern coast; but the 500 fathom line has a long extension north-westward, which is continued by the 1000 fathom line until it includes Lord Howe Island; while Norfolk Island, New Caledonia, and Queensland are all linked to New Zealand by the 2000 fathom line, which also includes the Chatham and Antipodes Islands on the east, and the Campbell Islands and Macquarie Island to the south; and this bank may perhaps be continued south-westward to Wilkes Land, the north-eastern projection of Antarctica.

2. Discovery and Settlement

New Zealand was first discovered by Europeans, on 13th December 1642, by Abel Tasman, who called it Staatenland. He saw the Southern Alps; sailed northward along the coast of the South Island to Cook Strait, which he named Zeehaan Bight, under the impression that it was only a gulf. The crew of one of his boats was murdered by the Maoris in Massacre Bay, and Tasman did not land on the coast. New Zealand was regarded as a peninsula projecting northwards from the then hypothetical Antarctic Continent, a view which was believed until disproved by Cook's circumnavigation in 1679. Cook's survey was extensive and accurate. He recognised the trend of both the chief mountain lines and named the Southern Alps. He charted the whole coast with only two serious mistakes — his representation of Bank's Peninsula as an island, and Stewart Island as a peninsula. After Cook's time the coasts of New Zealand were visited by whalers, who established stations at various places on the shore. But their settlements were temporary, and the whalers added but little to our precise knowledge of New Zealand geography. Missionary enterprise was begun in 1814; and it did much to establish friendly relations between the white people and the Maoris.

Attempts at permanent occupation were begun by Herd in 1825, and New South Wales appointed a British Resident in 1833. France then showed a desire to annex New Zealand, and thus, as Mr. Pember Reeves remarks, England, which did not want New Zealaml, was compelled formally to annex it, to keep out the French, who did want it. A New Zealand Colonisation Association was founded in 1837, and in 1839 the New Zealand Company began the active colonisation of New Zealand.

The country was formally annexed in June 1840, Auckland being selected as the capital. The proclamation of the colony and the formal appointment of the first governor, Captain Hobson, took place in May 1841.

The chief cities of New Zealand were founded by associations of emigrants. Thus Dunedin was founded in 1848 by Scotch settlers, Canterbury in 1850 by a party of English; both of them, as well as New Plymouth, Wellington, and Nelson, were founded under the auspices of the New Zealand Company. It failed in 1850, and its powers were taken over by the New Zealand Government.

The colony was at first divided into six independent provinces, governed separately under a system established by Grey's Constitution Act of 1852. Three extra provinces were formed later. Each of them had a parliament composed of a Legislative Council, of which the members were appointed by the Governor, and an elected House of Representatives. In 1876 the nine provinces were federated into one colony, and Wellington, which had already become the residence of the Governor, was made the seat of Government for New Zealand; and the one Parliament assembled there.

The great difficulty of the early government of New Zealand was in the quarrels with the Maoris. The quarrels were often due to the unwitting infringement by the whites of sacred rites based on the Maori faith in Tabu. The natives, moreover, did not understand that they had parted with their rights to land when they had sold it, and that they could not sell the same land more than once. They objected to British ceremonies, such as the erection of flagstaffs, to which they attributed magic properties. The chief Maori war lasted from 1860 to 1870. The Maoris were sporting foes, who gave

their enemies warning of attack, and supplied them with food. After they had adapted their system of warfare to the use of guns, they used to ask for a truce until they got fresh ammunition; they also demanded intervals for meals, because, they explained, they could not reasonably be expected to fight when they were hungry. They were no judges of water-supply, and their impregnable fortresses or "pas" could always be starved out in a few days for want of water. And so the Maori opposition was crushed for ever.

3. The Coasts

The geographical structure of New Zealand is dominated by two series of lines, one running from north-east to south-west, and a second running almost at right angles to the first from north-west to south-east. The lines from north-east to south-west are the most conspicuous, and are the later in age. They have given to New Zealand the long parallel eastern and western coast-lines of the South Island, and of most of the North Island. They have also determined the course of the main mountain axes of the South Island, of the Southern Alps, of the parallel ranges in the north-eastern part of the South Island, of the Kaikouras, and of their continuation in the North Island, the Rimutaka-Tararua-Ruahine - Huiarau - Raukumara mountain chain. The structural lines from north-east to south-west also determined the occurrence of the Wellington Peninsula, the Cook Peninsula, the north-eastern corner of the North Island, the northward projections of the provinces of Nelson and Marlborough on either side of Tasman Bay, and the Sounds of Marlborough.

The earth-movements along the line of the eastern

coast of New Zealand were continued northward, and their influence is marked by the long, narrow, deep, probably a suboceanic rift-valley, shown on the chart of the South Pacific (facing p. 1).

The most conspicuous feature due to the north-western and south-eastern lines is the Auckland Peninsula, with the old mountain lines of Coromandel and the Thames Peninsula, where, as is shown by Professor Cox,[1] the old rocks that form the base of the Colville Peninsula strike from north-west to south-east, or in that general direction; and the course of the shores of Cook Strait, especially from Cape Egmont to Wanganui, is due to movements with the same trend. The northern margin of Foveaux Strait, at the southern end of the South Island, belongs to the same series; but this shore trends from west-north-west to east-south-east. The separation of the mountainous highlands of Otago from the plains of Canterbury is also determined by a north-west to south-east line, of which we find evidence also in the Kakanui and the Hokanui Mountains.

The coasts of New Zealand are, as a rule, regular, owing to the comparatively recent date of the north-east to south-west earth-movements. On coasts determined by them there are few good harbours, except under the shelter of the off-lying volcanic peninsulas, to which are due Otago Harbour, opposite Dunedin, and the Banks Peninsula, with Lyttleton Harbour, near Christchurch. But, as a rule, the eastern and western coasts are in long curves, forming open bays or wide bights. In the South Island there are three on the eastern coast—Brighton Bight, Canterbury Bight, and Pegasus Bay; and two on the western coast—Westland Bight

[1] S. H. Cox, "Goldfields of the Cape Colville Peninsula," *Rep. Geol. Explor.*, 1882 (1883), pp. 6-7.

and Karamea Bight. In the North Island are the broad, open Hawkes Bay and the Bights of New Plymouth and Taranaki.

The long, straight shores are swept by powerful currents, and the sediment brought down by the rivers is piled up in bars opposite their mouths. Except where the entrances to the rivers are rendered navigable by extensive works, as at Greymouth, they are of little use for shipping. The best harbours occur in the deep, long fiords in the south-western end of the South Island, in the Sounds off Cook Strait, and the harbours of Auckland and the Thames in the North Island. It is only in these districts that the coasts are much indented. Hauraki Gulf, with the estuary of the Thames and the exquisite Auckland Harbour, and the Sounds of Marlborough, are typical instances of drowned valleys. The fiords of the south-western coast are typical, true fiords. They are as much as 1000 to 1500 feet in depth. They are bounded by straight, parallel walls, their branches and tributaries join the main fiords at sharp angles, and all through the district the same angle has a tendency to recur. The meeting of the seaward ends of fiords, cuts off parts of the coast as islands. The fiords are usually deepest inland, and are shallow at their seaward ends. It is claimed by some geologists that they have been carved out by glacier action, though this explanation of their origin seems to the author insufficient. Some of their characters are shown on the chart (p. 566) and views (pp. 565, 567) of Milford Sound.

The Marlborough Sounds, on the contrary, are not fiords but rias; they are valleys that increase gradually seaward, both in width and depth. The Sounds of Marlborough, Wellington Harbour, and Auckland estuary are the flooded portions of valleys running out to sea

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MITRE PEAK, MILFORD SOUND, N.Z.

between the axial mountain lines. The fiords occur in the plateau country of Western Otago, and may be described as occurring along a series of regular, intersecting tectonic fractures.

The New Zealand coasts are gradually growing sea-

MAP OF MILFORD SOUND, A TYPICAL NEW ZEALAND FIORD.

ward by the deposition of material brought down by the rivers; but they are kept fairly straight owing to the resorting of the river sediments by the ocean currents. The coast shows clear evidence of depression in the Sounds of Marlborough and the Hauraki Gulf; but there

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LOOKING UP MILFORD SOUND FROM WINDBOUND POINT.

is also evidence of local uplifts, such as that of five feet. along the coast near Wellington and Palliser Bay, caused by the earthquake of 23rd January 1855. Conspicuous evidence of recent uplift of the land or sinking of the sea is given by the raised beaches which occur along the eastern coast of the South Island.

4. The Mountain System

The mountains of New Zealand may be divided into four main groups, the members of which are generally conspicuous because of their comparative youth. The most conspicuous, and geographically the most important, are the two lines of mountains running from north-east to south-west. They are the chain of the Southern Alps, which forms the main axis and watershed through the South Island, and the Kaikoura-Ruahine-Raukamara chain in the North Island.

The Southern Alps are fold-mountains. They consist of a foundation of archean and plutonic rocks, which are best exposed along their western foot in Westland. The Alps extend from the Haast Mountains, in the southern end of Westland, north-eastward, parallel to the coast, to Separation Point, on Cook Strait. Numerous short spurs project from the main chain to the north-west, and separate short, steep valleys, which are occupied by the Franz Joseph, Fox, and Balfour glaciers. The main range of the Southern Alps continues northward through the Spencer Mountains and the St. Arnaud Mountains, past Mount Dun, famous for its chrome ores, to the shore of Cook Strait in D'Urville Island and Cape Stephen. At the northern end of Westland, a branch from the Southern Alps extends in a more northerly direction than the main chain, through the Victoria Range and the Brunner

Mountains, through Mount Arthur and Mount Richards to the coast at Separation Bay. The parallel off-lying Whakamarana Range forms the western part of the Tasman Mountains, between the Karamea Bight and Golden Bay.

The spurs on the south-eastern side of the Alps are naturally longer than those to the west, as the main slope of New Zealand is in that direction. The highest peaks of New Zealand, including Mount Cook, 12,350 feet, and Mount Malte Brun, are on these south-eastern spurs, which also include the Arrowsmith Mountains, the Birdwood Mountains, etc.

The long line of the Southern Alps forms an effective barrier between the eastern and western coastal districts in the middle of the South Island. At the southern end of the Alps is the Haast Pass, which is 1716 feet above sea-level; the next pass to the north, the Fitzgerald Pass, is 7000 feet in height; to the north follow other high-level passes, which are practicable only on foot, including the Sealy Pass, the Whitcombe Pass, and Mathias Pass; it is not until as far north as the Arthur Pass, at the height of 3038 feet, between the head of the Bealey River, a tributary of the Waimakariri River, and the Otira River, a tributary of the Teremakau, that a practicable coach road occurs across the Alps. This road connects the Canterbury Plains with Greymouth and the goldfields of Westland. Then follows some more high passes—Harper's Pass, Hope Pass, etc., practicable as bridle tracks; and, finally, the chain is crossed by a road between the Wairau River and the head of the Roto-iti River, a branch of the Buller, between Mount St. Arnaud (5521 feet) and Beeby's Knob (4712 feet).

It was not until the discovery of gold in the early 'sixties that serious attempts were made to reach West-

land, which has not yet been placed in railway connection with the eastern coast. The only road, a great engineering feat, goes down the Otira Gorge; while communication north and south along the coast-plain of Westland is difficult and uncertain, owing to the floods, which often render the rivers unfordable for days together.

Photo. A. E. Kitson.

MOUNT COOK, LOOKING UP THE TASMAN VALLEY ACROSS LAKE PUKAKI.

The chief summits of the Southern Alps are around Mount Cook. This attractive and magnificent mountain region has been described in a considerable climbing literature, including the works mentioned below,[1] as well

[1] W. S. Green. *The High Alps of New Zealand.* London, 1883.

G. E. Mannering. *With Axe and Rope in the New Zealand Alps,* 1891, xi., 139 pp., 1 map.

as in the Annual Reports of the Lands Department of New Zealand.

The remains of another long mountain chain occur on a line parallel and to the east of the Southern Alps. It runs from north-east to south-west, but it extends farther to the north than the Southern Alps. Its southern end is to the north of the Canterbury Plains. It crosses the south-eastern district of Nelson and the Province of Marlborough. It consists of two main ranges, the Inland Kaikouras, between the Clarence River and the Wairau, and the Seaward Kaikouras, between the Clarence River and the coast. The Seaward Kaikouras are continued north of the Clarence River in Ben More, 4075 feet; and reach the coast near Weld Cone and Cape Campbell. The Inland Kaikouras are continued through Mount Malvern and Mount Haldon, and reach Cook Strait between Cape Campbell and the Awatere River. Both the Kaikoura lines appear to be continued north of Cook Strait, where the Kaikoura fault system is well shown near Wellington. The Seaward Kaikouras are represented for a short distance by the Haurangi Mountains, north of Cape Palliser, and the Puketoi Mountains. They are geographically a continuation of the Seaward Kaikouras. The Inland Kaikouras are continued by a long continuous chain, beginning in the south with the Rimutaka Mountains, near Wellington. Then follow in order the Tararua Range, the Ruahine Range, the Huiarau Range, and the

M. Ross. *Aorangi.* Wellington, 1892, 64 pp. and 20 maps and illustrations.

E. A. Fitzgerald. *Climbs in the New Zealand Alps*, 1896, xvi. 363 pp., maps.

A. P. Harper. *Pioneer Work in the Alps of New Zealand*, 1896, xvi. 331 pp., map.

New Zealand Alpine Journal, vol. i. 1892, etc.

Raukumara Range, which reaches the northern coast in the Cook Peninsula. Parallel with this chain, and to the west of it, is the Kaimanawa Range.

These ranges are generally regarded as containing no rocks older than the Carboniferous; but the lithological characters of the rocks of the Ruahine Range, as described by M'Kay,[1] with their thick quartzites, jasperoids, diabase, and serpentine, suggest that a much earlier system is represented. The remains of another parallel chain are indicated in Mount Tuhua; it was probably once connected with the Ruahine Mountains, and is now separated by the sinking of the Taupo volcanic basin.

The third group in the New Zealand mountain system includes the remains of the transverse mountain lines, running from north-west to south-east. The best representative of this group in the North Island is the Coromandel Range, between the Thames estuary and the north-eastern coast. This range is geologically famous for its important goldfields. The strike of the old Palæozoic rocks that form its foundation is north-westerly.

The most important mountains of this system are those which form the old and now intensely dissected peneplane of Otago. The Southern Alps do not extend through the whole length of the South Island, as they end at Cascade Point in Westland. Otago is composed of an old plateau of which the surface was a peneplane, with a long slope south-eastward to the coast, between Invercargill and Dunedin. The denudation of the deep valleys of Otago has dissected the plateau and left a series of residual mountain ranges, trending from north-west to south-east. The first of them leaves the southern end of the Southern Alps as the Barrier Mountains, and

[1] A. M'Kay. *Rep. Geol. Explor.* 1887-88, No. 19 (1888), p. 60.

is continued eastwards as the Kakanui Range. The second important line begins in the north-west, at Mount Aspiring (9975 feet), and continues as the Crown Mountains and Hector Mountains. A third line begins at Mount Edward (8459 feet), passes through Mount Earnshaw (9165 feet), and after passing through the Richardson Mountains to the east of Lake Wakatipu, crosses that lake at its sharp bend, and continues as the Eyre Mountains, to the west of the southern arm of Lake Wakatipu. The next of the mountain lines, cut by denudation from the Otago peneplane, begins at Mount Cosmos (7340 feet), passes through the Ailsa Mountains and the Livingstone Mountains between Lake Wakatipu and Lake Te Anau, and is continued through Mount Prospect and the Takitimu Mountains (5559 feet).

The peneplane structure of Otago is well shown by the views on the railway line between Invercargill and Otago, especially around Gore and Waipahi.

5. The Volcanoes

The fourth group of New Zealand mountains includes those which are volcanic in origin, though most of the volcanoes are now extinct. None of the volcanoes of the South Island are active; and though hot springs are numerous, their waters are probably of plutonic origin, or may owe their high temperatures to passage through rocks heated by earth movements still in progress. As is usually the case, the New Zealand volcanoes occur on the borders of sunken areas; and they help to mark out the latest of the great earth movements. Thus the two chief volcanic centres of the South Island, which formed the peninsula near Dunedin and Banks Peninsula,

HOT SPRINGS ON COPLAND RIVER, N.Z.

indicate the subsidence of the land which once extended eastward from the South Island.

In the North Island, Mount Egmont, which rises from the shore line at Taranaki to the height of 8250 feet, is a graceful and snow-clad volcanic cone; it is obviously of more recent age than either of the volcanic groups of the South Island. It occurs near the point of intersection of the subsidences west of New Zealand and those along Cook Strait. Mount Egmont has a well-preserved crater, but the volcano is extinct.

The chief area of volcanic activity in New Zealand is in the Taupo district of the North Island. Suess has pointed out that there is no representative in the North Island of the ancient basement rocks of the Southern Alps. These rocks disappear below Cook Strait, and in continuation of their line of strike in the North Island there are the marine deposits of the Wanganui basin. To the north of Wanganui are the volcanic plateaus and craters of the Taupo district and the Bay of Plenty. This area is bounded to the east by the folded mountains of the Ruahine-Raukamara chain. The volcanic area probably contained a continuation of the Alpine chain of the South Island. This area has sunk between two powerful lines of faults, forming a basin, the southern part of which was filled by the marine rocks in the Wanganui valley, and the northern part by the volcanic rocks of Taupo. The former northern extension of the old Alpine chain has been thus completely hidden. The Taupo volcanic area includes a series of high plains, such as the Kaingaroa Plains, composed of lava and volcanic ash, the surface of which is abundantly strewn with beds of fragmentary pumice. Above these plains rise the great volcanic cones, Ruapehu (9175 feet), Ngauruhoe (7515 feet), Tongariro (6458 feet), which occur on a

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MOUNT NGAURUHOE (7515 FEET), SOUTH OF LAKE TAUPO, N.Z.

line at the southern end of the Taupo area. Ruapehu still shows signs of activity, and so also does the crater on the summit of the perfect cone of Ngauruhoe. Tongariro is extinct and more weathered. Farther north occurs a series of dissected volcanic cones, including Tauhara, Mount Edgecombe, and Maungakakaramea or the Rainbow Mountain. White Island, in the Bay of Plenty, is still in the solfatara stage. The Taupo area also includes a series of flat-topped block mountains, formed of sheets of lava broken up by faults; the chief are Tarawera, Tuahu, Haparangi, Paeroa, Horohoro, Tutukau, Pareheru, Maungaongaonga, etc.[1] In the district around Auckland occur a group of scoria cones resting on sheets of basalt; many of these volcanic hills have well-preserved craters, such as Mount Eden in the suburbs of Auckland and the Three Kings, a little farther from the town. The craters were occupied by the Maoris as fortresses. Rangitoto, on an island in Auckland Bay, is a beautifully regular, low lava cone, capped by a small scoria cone.

6. The Tarawera Eruption

The most remarkable of the volcanic eruptions of New Zealand was that of Tarawera on 10th June 1886, which destroyed the most famous of the scenic features of New Zealand—the Pink and White Terraces of Rotomahana. Tarawera is one of the flat-topped, lava-capped block mountains; it is situated on the south side of Lake Rotorua. It is close by the small hot lake of Rotomahana, on the shores of which were a series of hot

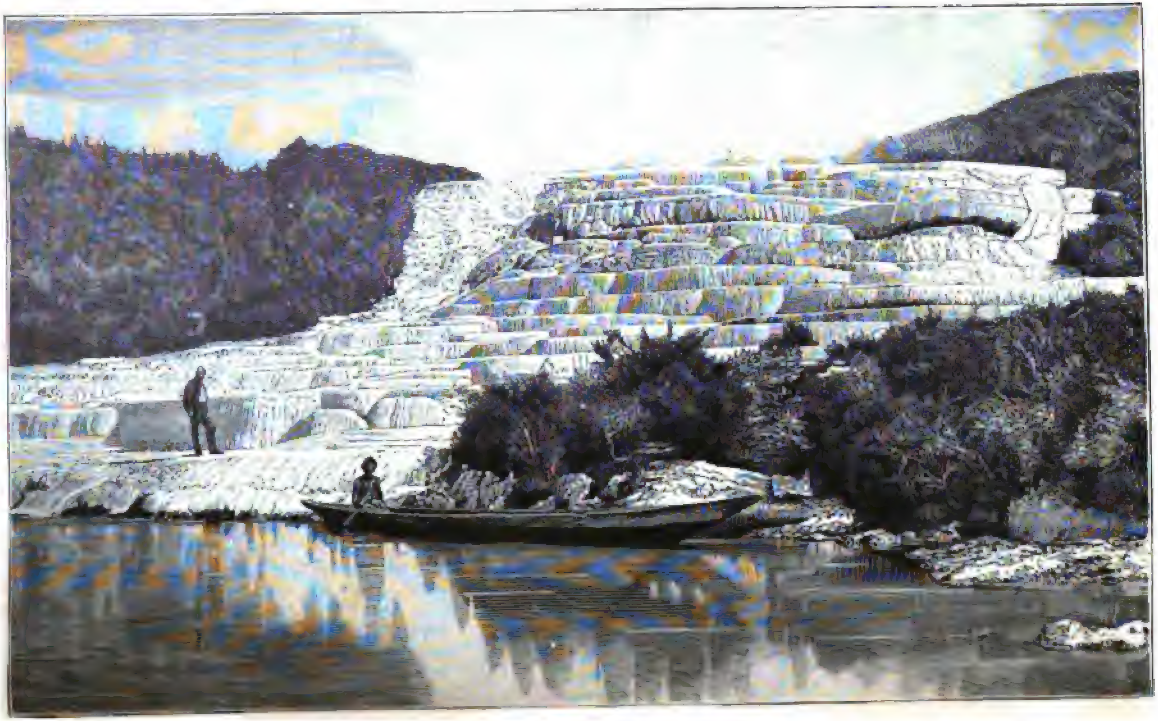
[1] I can only be sure about the fault formation of some of the mountains in this list; but judging by distant views or descriptions, the remainder probably have the same formation.

springs and some terraces of siliceous sinter, which, owing to their exquisite colours, were no doubt the most beautiful sinter terraces in the world. On the night of 10th June 1886 Mount Tarawera was suddenly rent by an eruption of paroxysmal violence and intensity. The eruptions burst out along a line nine miles in length, upon which were formed a series of craters; violent explosions from them formed a vast volcanic rift.

The fullest account of the eruption is given in the reports by Mr. Percy Smith, then the Surveyor-General for New Zealand, by the late Professor Hutton and Professor Thomas of Auckland, issued by the Lands Department of New Zealand in 1886 and 1888. The most detailed report is that by Mr. Percy Smith (1886). Earlier accounts of the eruptions were published by Sir Julius Hector in *Nature*, vol. xxxiv., 1886. The eruption began about 1.30 A.M. by the ascent of a high column of steam from Wahanga, followed about 2 A.M. by a great column of vapour from Ruawahia. Violent earthquakes occurred a few minutes afterwards, and then Tarawera broke into eruption. The first rain of material on Wairoa occurred about 3 A.M. Numerous earthquakes were felt throughout the eruption at Rotorua, about fourteen miles away, but they did no damage there, not even upsetting bottles upon shelves. The explosion at Rotomahana occurred shortly after 3 A.M., and by 3.30 a violent eruption was proceeding along the whole length of the fissure, from Wahanga on the east to near Lake Okaro on the west. Volcanic ashes fell on Wairoa and Rotorua about 4 o'clock. The main eruption was over by 6 A.M. Wahanga stopped between 9 and 11 A.M.; but steam and dust were ejected along the fissure for some days, and the steam column, even on the 13th, rose to the height of 25,000 feet above the sea.

The paroxysmal stage of the eruption lasted only about two hours, and the serious damage was done by two chief explosions. The volcanic ash near Mount Tarawera accumulated up to 200 feet in thickness; but this thick bed was very local in extent. Volcanic dust was scattered in a thin layer over a large district. The lava that accompanied the eruptions was an augite andesite; but the author found in 1904 that this rock had been also produced along the Tarawera fissure by earlier eruptions, which had not been limited to acid lavas. The fissure left by the eruptions was in places more than 1000 feet in depth, and it is nine miles long.

It has been maintained that this outburst was not a true volcanic eruption, but was due to hydrothermal action or an explosion of superheated steam. This description is not inaccurate regarding the explosion, which destroyed the Pink and White Terraces, and formed the deep basin of Lake Rotomahana. But the eruption of Tarawera, an hour earlier, was accompanied by the ascent of lava and was a true volcanic eruption. The preliminary eruption was doubtless caused by the ascent of lava along a fissure, the course of which is marked by the rift. The second stage of the eruption was caused by the ascent of some of the lava into rocks beneath Lake Rotomahana, which were saturated with superheated steam. The sudden increase of temperature, due to the ascent of the heated lava, caused the superheated water to burst into steam in a tremendous explosion, which blew a hole 500 feet in depth beneath the Terraces, and scattered their fragments over the district. The eruption was accompanied by many small earthquakes, the intensity of which, except in the immediate area, was small. Very little lava was discharged, but the explosion produced an enormous quantity of



WHITE TERRACES, ROTOMAHANA, N.Z. (Destroyed by explosion during the eruption of Mount Tarawera in 1886.)

volcanic dust, which was shot high into the air and fell in solid rain on the surrounding country. The ground around Lake Rotomahana was also covered deep with the muds that had collected on the bed of that lake. The nearest Maori settlement was annihilated, and there was considerable loss of life at Wairoa on the other side of Lake Rotorua, where the people were buried under the ruins of their houses, the roofs of which fell in under the weight of volcanic ash. The most striking feature of the eruption was the long volcanic rift which was left along the line of the explosions. On its floor was the Great Black Geyser, Waimangu, the greatest geyser hitherto known. It first burst into eruption about February 1901, and has shot a column of black water to the height of 1500 feet above its mouth.

The Taupo volcanic area is famous for its geysers and hot springs.[1] A most instructive group of geysers occurs in the valley at Wairakei. The geysers of Whakarewarewa are less active than they were before 1886. Mud volcanoes occur, as at Waiotapu. Hot springs are frequent in many parts of the Taupo volcanic district, of which the chief are Tokaanu, Waipapa, Orakei-korako, and Tikitere; those at Waiotapu are producing a beautiful sheet of siliceous sinter.

7. The Faults of New Zealand

New Zealand shows the direct effect of earth movements with remarkable clearness.

The volcanic area of Taupo is bounded to north-west and south-east by powerful faults. Some of the faults can be recognised across the Taupo area, and they bound

[1] An account of some of these geyser groups is included in Marshall's *Geography of New Zealand*, 1905, pp. 189-200.

its flat-topped, lava-capped mountains. Two such faults run parallel to the Tarawera volcanic fissure and determine the scarp of the Paeroa Mountains.

In the South Island a great fault system has had still more marked geographical effects. Powerful faults, of recent geological date, are directly connected with the

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GEYSER.

existing topographical features of New Zealand, as has been clearly pointed out by A. M'Kay, till lately the Government Geologist of New Zealand.

The most striking of these faults are those of the Kaikoura system, which occurs in the Marlborough district, at the north-eastern corner of the South Island. M'Kay has shown that the main topography of the Kaikoura Mountains has been determined by three chief faults. The first, and most easterly, the Kaikoura Fault,

crosses Ben More and runs south-westward along the coastal side of the Seaward Kaikouras as far south as the Conway River; there it bends to the west-south-west, traverses the upper part of the valley of the Waiau-ua River, and is regarded by M'Kay as traversing the Alps and occurring on the western coast south of Hokitika. According to M'Kay this fault has a throw in places of from 10,000 to 13,000 feet. The second fault, which he calls the Great Clarence Fault, is one of the most striking features in the geography of New Zealand. It follows the course of the Clarence River, determining the position of the valley which separates the Inland and the Seaward Kaikouras. It is also found on the North Island to the west of Wellington, where its existence supports the connection of the Kaikouras and the main eastern chain of the North Island. Farther southward it is regarded by M'Kay as being recognised across the headwaters of the Ashburton River, and as forming the central reach of Lake Wakatipu, and as running from Lake Manapouri to the southern coast at the western end of Foveaux Strait. The third fault is that of the Awatere River, which follows the course of the Awatere River, on the western side of the Inland Kaikouras. It crosses the Kaikoura Fault at Glenwie. A long line of igneous rocks occurs for some distance along this fault in the Awatere River. A band of post-Miocene conglomerate is let in along the line of the Clarence Fault, and demonstrates the comparatively recent geological age of the fault. The effect of these faults on the structure of the Kaikoura Mountains is shown in M'Kay's instructive sections.[1]

[1] A. M'Kay. *Reports of Geological Explorations.* New Zealand, 1891. No. xx. pp. 96, 97.

8. Earthquakes

The effect of these faults is of great interest in connection with the earthquakes which affect the districts of New Zealand, where these faults are best developed, as in the neighbourhood of Wellington, the Cheviot Hills south of the Kaikouras, and the adjacent districts along the eastern coast, as far south as Christchurch.

The elevation of the coast near Wellington in 1855 is regarded by M'Kay as due to a movement which reopened a fracture connected with one of the Kaikoura Faults of the South Island. On the 16th November 1901 an earthquake of unusual violence took place in the Cheviot District and in Northern Canterbury. The earthquake displayed its greatest violence along a line nearly parallel to the Great Clarence Fault, and M'Kay regards it as having been due to a new movement along one of the fault lines belonging to this series. The earthquakes produced well-marked lateral displacements of the ground, a series of earthquake rents, and small fault scarps. In one place in the same district an earthquake, in September 1888, produced a lateral movement of the ground for nine feet along a fault; the effect was shown by the sharp displacement of a straight wire fence, which was left sharply bent by the movement of one end of the fence.[1]

It is a significant fact that in New Zealand the most powerful earthquakes occur along the great fault lines and not in the volcanic districts. The earthquakes are most destructive from Wellington to Christchurch, and those of the Taupo volcanic belt are insignificant.

[1] A. M'Kay. *Report on the Recent Seismic Disturbances within Cheviot County in Northern Canterbury and the Amuri District of Nelson.* Wellington, 1902, p. 28.

Mr. Geo. Hogben,[1] the chief authority on the earthquakes of New Zealand, enumerates 775 between 1848 and 1890, exclusive of those connected with the eruption of Tarawera. The chief centres, in order of earthquake frequency, are Cook Strait, Christchurch, and Nelson; then follow New Plymouth, Masterton, and Reefton; then Hokitika, with Greymouth and Westport. There is an isolated area of earthquakes round Rotorua and Tarawera, and another area of local earthquakes (of which the records are very scanty) around Queenstown.

9. New Zealand Plains

The plains of New Zealand are comparatively limited in area; but they are of great economic importance owing to their use as the sheep-runs which made the first important contribution to New Zealand wealth. The plains may be divided into the seven following groups:—

1. Southern Otago consists of an intensely dissected peneplane, sloping downward from the north-west to the south-eastern coasts.

2. The floors of the river valleys which have been cut in the Otago Peneplane include many broad river plains, which are especially well shown in the valley of the Mataura River near Gore, and can be seen from the railway between Invercargill and Dunedin.

3. The Canterbury plains are the most extensive in New Zealand. They have been formed by river action, and consist of a series of river-fans made of debris discharged from the narrow valleys in the Southern Alps. These fans of river debris are confluent into a fairly level and continuous plain. The steady slope of

[1] He has contributed a general account of the subject to Marshall's *Geography of New Zealand*, pp. 200-224.

the plains, from the coast to the foot of the hills, is shown by the levels of the railways running inland from Christchurch. The rivers which have formed the plains now traverse them in mile-wide belts of shingle, across which, under normal circumstances, the rivers flow in numerous small, shallow, and ever-shifting channels. There is much more shingle than water upon the river beds.

4. In places where a river has been barred in its lower course, its waters spread out as a lake, the bed of which was covered by sheets of mud; the subsequent drainage of the lake, partially or completely, has left the old lake bed as a sheet of rich alluvium. Typical instances of such lake-plains can be seen on the basin of the Taieri, to the south of Dunedin.

5. On the western coast of the South Island is the narrow coast-plain of Westland, which has been formed in the same way as the wide Canterbury plains on the eastern side of the island. The Westland plain is more narrow and its surface less regular than the Canterbury Plains, as the rivers which formed it are shorter and have a steeper fall. The powerful current which sweeps along the coast of New Zealand keeps the coast line regular, by filling up the heads of the bays and preventing the seaward growth of the deltas.

6. The basin of the Wanganui and most of the southern part of the North Island was originally a plain formed of marine deposits; the plain has been uplifted and then dissected, by the formation of the deep gorges of the Wanganui and other rivers that flow southward into Cook Strait. The deep gorges of these rivers owe their steep walls to the tendency of the rocks of this district to weather in vertical cliffs.

7. The North Island contains extensive high, inland,

volcanic plains, including the Kiangaroa Plains, the Paeroa Plains, the other plains in the Taupo district, and the Patetere Plateau.

10. The Rivers

The main divide of the North Island follows the long chain of the Tararua-Raukaumara Chain, except that the divide in the central part sweeps westward to follow the course of the Kaimanawa Range. The eastern drainage from this mountain chain flows in numerous short, steep rivers to the eastern coast, of which the chief are the Waiapu, Waipoa, Mohaka, and Ngaruroa. A valley in the Wellington Peninsula, parallel to the main chain, is drained by the Ruamahanga River.

The rest of the North Island is divided into five chief basins. The southern basin drains into Cook Strait, and its chief rivers are the Wanganui, Manawatu, and the Rangitikei. The Wanganui—the so-called Rhine of New Zealand—is famous for the fine scenery along its deep precipitous gorge. The precipitous nature of its cliffs and the scarcity of tributaries had led to the view that it is a great volcanic rift. It is, however, unquestionably due to ordinary river action, the exceptional steepness of its cliffs being due to the fact that they are composed of material which is soft and easily removed by corrosion, but, like loess, will remain standing with vertical cliffs.

The drainage into the Bay of Plenty is now unimportant, the chief river being the Rangitaiki. But this basin was at one time much larger, for, as shown by Cussen, the drainage from the Taupo Plains must once have gone northward into the Bay of Plenty. It has now been captured by the Waikato River.

The drainage system into the Gulf of Hauraki, through

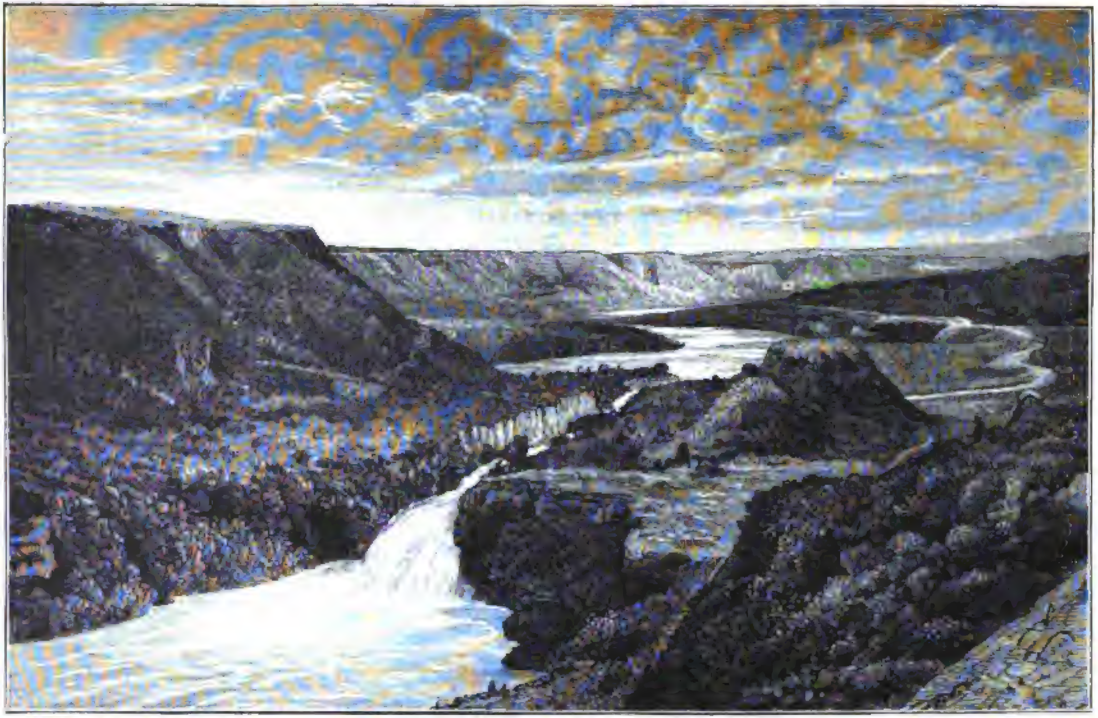
the estuary of the Thames, has also been cut short by the Waikato.

The Waikato, which discharges into the western coast, is the largest river in the North Island, and is 270 miles in length. It receives the drainage from Lake Taupo, after leaving which it plunges over the Huka Falls into a deep trench cut on the floor of its old valley (p. 584). It once continued through the Waiotapu valley into the Bay of Plenty; but it now passes through the mountains in a series of young narrow gorges, and makes its way to the western coast. To the south of the Waikato occur several smaller rivers, such as the Mokau, draining to the western coast.

In the north-western end of the North Island the chief river is the Wairoa.

The river system of the South Island is somewhat simpler than that of the North. There is a long divide on the western side of the island running from south-west to north-east, parallel to the coasts. The western drainage flows in short torrential rivers into the Southern Ocean. The rivers are subject to violent floods, and their beds are strewn with coarse shingle. Generally they are easily forded; but after heavy storms of rain, and the melting of the snow on the Alps, they remain impassable for days. The chief of these rivers, coming from south to north, are the Haast, the Karangarua, the Cook, the Waiho, Wataroa, the Teremakau, the Hokitika, and the Grey. Farther north is the Buller, which is a compound river, and the most important of the western coast. It has grown by the capture of some of the upper tributaries of the Grey and of the Motueka River, which drains into Cook Strait.

On the eastern coast there are a series of powerful rivers, which discharge the drainage down the eastern



THE HUKA FALLS ON THE WAIKATO RIVER, TAUPO, WHICH HAS CUT A DEEP TRENCH IN THE TAUPO VOLCANIC PLAINS.

slopes of the Alps and from the famous "cold lakes" of Otago. The chief of the eastern rivers is the Clutha or the Molyneux, which has the largest volume of any river in New Zealand. The Clutha discharges the drainage from Lakes Hawea, Wanaka, and Wakatipu. The Mataura drains the country to the south of Lake Wakatipu, but receives none of the waters from that lake, with which, according to Marshall, it was probably once connected. The Waiau River discharges the waters of Lakes Te Anau and Manapouri. The Canterbury plains are traversed by a series of ancient rivers, some of which date back to Miocene times. They rise on the eastern slope of the Southern Alps and traverse the foothills through deep gorges; and emerging from the mountain valleys into the plains, they flow to the sea, across old delta fans, which the rivers themselves have made. These rivers are too shallow and irregular to be of much economic value, and owing to the width of the sheets of shingle on their beds are often called "shingle rivers" (p. 591). The chief of them are the Waitaki, Rangitata, Waimakariri, and Hurunui. Marlborough is traversed by three rivers, which flow from south-west to north-east in valleys determined by the parallel faults of the Kaikouras. They are the Wairau, Awatere, and the Clarence.

11. The Glaciers

The highest mountains of New Zealand rise above the level of perpetual snow, and part of their snowfall is discharged through glaciers. In the North Island, Mount Egmont, Ruapehu, and Ngauruhoe have each a calotte of snow and ice. In the South Island there is a series of extensive glaciers, of which the Franz Joseph

Glacier flows down to the level of only 600 feet above sea-level. The largest of the glaciers discharge to the east. The most important is the great Tasman Glacier, which rises in the snow-field between Mount Elie de Beaumont and Mount Darwin, and is joined by the

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AT BEALEY, LOOKING OVER THE SHINGLE-FLAT OF THE WAIMAKIRIRI RIVER.
With Mount Rolleston in the distance.

Rudolf Glacier from Mount de la Beche, the Haast Glacier from Mount Haidenger, the Hochstetter from Mount Tasman and Mount Cook, and on the eastern side by the Darwin and Bonney Glaciers from the Malte Brun Range. The Murchison Glacier flows down the valley to the east of the Tasman Glacier, from which it is separated by Mount Malte Brun. It is the source of the Murchison River, a tributary of the Tasman

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FRANZ JOSEPH GLACIER, FROM SENTINEL ROCK, N.Z.

River. The Hooker Glacier and the Mueller Glacier occur farther to the south-west, running in valleys parallel to the main divide, from Mount Stokes to Mount Burns. In the western valleys of the same region of the Southern Alps, the chief glaciers are the Franz Joseph Glacier, which, after a very steep slope, ends at the height of 600 feet above sea-level; its waters discharge into the Waihó River. Farther to the south lie the Fritz Glacier, the Victoria Glacier, the Fox Glacier, the Balfour Glacier, and the Douglas Glacier. Farther to the north are the Godley Glacier by the Sealy Pass, the Ramsay and Lyell Glaciers at the head of the Rakaia valley, and several groups of less known and smaller glaciers, at intervals along the main crest of the Southern Alps.

The rate of flow of several glaciers has been measured. The eastern glaciers appear to be sluggish in their movements. According to Mr. J. H. Baker,[1] the daily rate of the Hooker Glacier, three-quarters of a mile from its lower end, in April 1890 varied at different points across the glacier from 1·16 inches to 4·51 inches a day. The Mueller Glacier, according to a mean rate of nine stations for a period of 1 year 230 days (29th March 1889 to 14th November 1890), is moving 6·7 inches a day. The Murchison Glacier is moving at a mean rate of 4·92 inches a day. The Tasman Glacier, from observations at eight stations opposite the Ball Glacier, has a mean rate of 15·6 inches a day, and along a line from the spur of Mount Malte Brun, the mean daily rate, calculated from eight stations, is 11·1 inches.

The steep Franz Joseph Glacier, according to Harper, flows at the rate of as much as 16 feet a day; but

[1] "On Mount Cook Glacier Motion," *Rep. Austral. Assoc. Adv. Sci.* vol. iii. 1891, pp. 153-161.

measurements made by the late C. Thomson and myself in January 1904, gave the rate below the lower ice-fall as 1·4 inches a day.

12. The Lakes

The lakes of New Zealand are famous for their fine scenery. They are divided into two groups, those of the volcanic region of the North Island, and those in narrow, fiord-like valleys in the alpine region of the South Island. The largest lake in the volcanic district is Lake Taupo, 238 square miles in area. It occurs 1211 feet above sea-level, and its present depth is 534 feet. The raised beaches on its shore show that its surface was once higher. The lake is fairly flat-bottomed.

The shores of Waikare' Moana, another large lake in the North Island, are marked by numerous peninsulas and gulfs, formed by the flooding of the ends of valleys that enter it. Its greatest depth, according to Keith Lucas,[1] is 846 feet, and its surface 2015 feet above sea-level.

The fiord-like lakes of Otago, in the South Island, lie in long narrow valleys, and their basins are doubtless of the same origin as those of the fiords that open to the sea on the south-western coast. According to the soundings of Keith Lucas the surface of Lake Wakatipu is 1016 feet above sea-level, and its depth is 1239 feet; and Lake Manapouri is 597 feet above sea-level and 1462 feet deep.

13. Geology

The geology of New Zealand is of especial interest, as it contains an exceptionally complete series of both

[1] Lucas. "A Bathymetrical Survey of the Lakes of New Zealand." *Geogr. Journ.* vol. xxiii. 1904, p. 650.

sedimentary and volcanic rocks. New Zealand appears to have been on the border of a continental area from earliest geological times, and the oscillations usual in such positions have led to its alternate depression beneath the sea and its elevation as land. New Zealand, therefore, contains an unusually complete sequence of sedimentary rocks; and its fossils are of special interest, as the fullest record of the faunas of the Southern Pacific area and of any far southern land. The first extensive collections were described in the "Palæontologie von Neu Seeland" by Unger, Zittel, Suess, Karrer, Stoliczka, Stache, and Jaeger, issued as one of the volumes of the *Reise der Novara*, 1864. The palæontological wealth of the colony can be realised by an examination of the magnificent collection of fossils, made by the Geological Survey of New Zealand, now in the museum at Wellington. Most of this material, however, is unfortunately still undescribed.

The tectonic structure of New Zealand is varied and complex, and it is closely related to its topography. The physical geography, as shown in the account on p. 562, is dominated by two intersecting lines of mountain and earth movements, and the arrangement of these lines directly expresses the geological structure of the country. The volcanic history also is long and exceptionally full of interest. The country includes some great volcanic cones, including Banks Peninsula, the mountains around Dunedin Harbour, and Mount Egmont, which stand on the borders of foundered areas. The Taupo volcanic basin in the North Island is world-famous for its hot springs and geysers, its sinter terraces, and the explosive eruption of Tarawera. The effect of earth movements on the topography of the country is shown in the Kaikoura Mountains, and probably also in the angular courses of the troughs occupied by the New

Zealand fiords and the lakes of Otago. The importance of direct earth movements on the existing geographical features of New Zealand was first adequately realised by M'Kay.

The New Zealand geological sequence begins with the Archean system, represented by vast masses of schists and gneisses, which are most extensively exposed in Otago; they outcrop along the western flanks of the Southern Alps through Westland, and range thence north-eastward through the province of Nelson, in the north-west of the South Island. This system has been called the "Wanaka Series" by Hutton and Ulrich. So far as is yet known there is no representative of this system in the North Island; but the description given by M'Kay[1] of some rocks, which form the base of parts of the Tararua and Ruahine Mountains, shows that they strikingly resemble the upper Archean (Heathcotian) rocks of Australia. M'Kay, however, includes these jasperoids and diabases in the Wairoa beds; but the evidence for this age is not convincing.

The Palæozoic group is well developed. The lower Palæozoic is represented by the Takaka series. No Cambrian rocks are yet known. The Ordovician system is represented by the Aorere beds, developed along the Aorere River, which flows into Golden Bay, at the north-western corner of the South Island. The rocks of the Aorere series consist of slates, containing numerous Ordovician graptolites, including *Didymograptus*, *Tetragraptus*, *Dichograptus*, and *Phyllograptus*. The Baton River beds, developed in the basin of the Motueka River, which flows into Tasman Bay, are probably the best representatives of the Silurian.

[1] A. M'Kay. *Rep. Geol. Explor.* No. xix. 1888, pp. 4-6, 60; No. xviii. 1887, pp. 216-217.

The Reefton series consists of shales, slates, and limestones, and is well exposed in the Reefton mining field in the South Island. Their fossils indicate that the beds are Devonian.

The Carboniferous system is represented by the whole or a part of the Maitai system. This system includes a thick series of slates and sandstones. It constitutes the main bulk of the Southern Alps, and occurs in branches to the south-east, reaching the eastern coast near Oamaru, including the Kakonui Range. Mount Torlesse, to the east of Christchurch, is another detached area of the Maitai rocks, which are also well exposed in the Kaikoura mountains, and in the hills to the east of the city of Nelson. They also form the main part of the eastern mountain axis in the North Island, building up the Tararua, Ruahine, and Raukamara range.

The age of the Maitai beds has been considerably discussed. Among the fossils are species of *Productus*, characteristic of the Carboniferous rocks of Australia. On the other hand, Professor Park has collected fossils in this formation, which are of Mesozoic and probably of Jurassic age. It is therefore probable that the Maitai beds include both Carboniferous and Jurassic rocks. *Torlessia* (Bather), the common annelid in the Maitai series, occurs at Mount Torlesse and in Wellington, but not in the typical Maitai beds of the Maitai River near Nelson.

The late Professor Hutton suggested that some of the Maitai beds were of deep-sea origin, and thus explained the paucity of fossils; but the lithological nature of the beds does not support this hypothesis.

The last of the Palæozoic rocks is the Kaihiku series, correlated with the Permian. It includes the sandstones near Clinton and on the Upper Rangitata.

The lower Mesozoic beds are grouped together as the Hokanui system, of which the lower part, the Wairoa series, is unquestionably Triassic. It contains many marine fossils of the Triassic fauna, which occurs at intervals around the whole of the Pacific Ocean. The characteristic fossil of the Wairoa series is *Monotis salinaria*. The upper Triassic Otapira series is characterised by *Spiriferina spatulata*. The upper part of the Hokanui system consists of the Mataura beds, which are partly estuarine, alike in Otago, at the mouth of the Waikato River in the North Island, and in the King Country to the north-east of Auckland. In Wairarapa County, on the eastern coast of the North Island near Hawke's Bay, there are oil shales and gas springs, which, according to Park, are either Jurassic or Lower Cretaceous.

The Cretaceous system is represented by two different types, and by three, if Hector be correct in placing the Amuri beds in the Neocomian. The Waipara series of south-eastern Otago consists of a belt of Cretaceous limestones, which, at Clarendon, contain phosphates. The beds are marine, chalky limestones with such fossils as Belemnites, Ammonites, Scaphites; and also marine Saurians, allied to those of North America, including *Cimoliosaurus* and those called by Hector *Taniwhasaurus* and *Mauisaurus*. The Moeraki Boulders, famous in Maori tradition, are a layer of flattened boulders, covered by cone-in-cone structure, lying above a bed of greensand in the Cretaceous series at Moeraki Point, eastern Otago. The Cretaceous system includes, on the western coast of the South Island, the coal measures of Greymouth and Westport, which yield valuable seams of high quality steam coal. The Cretaceous coals have been worked for thirty years in the North Island, north of Auckland, in the Kawakawa coalfield, and at Hikurangi on the Bay of

Islands; in both cases the horizon of the coal is shown by its occurrence under the Whangarei or Waiomio limestone.

The Cainozoic group is represented by beds belonging to the Oligocene, Miocene, Pliocene, and Pleistocene systems. The Oamaru limestones and the brown coal measures of Waikato belong to the Oligocene system. The Oamaru limestones occur on the eastern coast of the South Island; they are marine in origin, and are largely made up of fragments of bryozoa with foraminifera, mollusca, and the teeth of various sharks (*e.g. Carcharodon angustidens*) and toothed whales, such as *Squalodon serratus*. It also includes the oldest known penguin, which was described by Huxley as *Palæeudyptes antarcticus*. The Oamaru limestone, although unusually porous, has been largely used for building stone, not only in New Zealand but in some of the Australian cities. The Oligocene is also represented by some brown coals and lignites, and they are associated with oil shales, some of which, as at Orepuki, 43 miles west of Invercargill, contain 47 per cent of oil and gas, with 8 per cent of water. The Miocene system is represented by the Pareora beds, ranging above sea-level to the height of three or four thousand feet, and they occur in both the North and South Islands. They contain many fossils of the same species as the Oamaru series, but they rest upon these beds unconformably. On the western coast the Miocene is represented, according to M'Kay, by the Moutere gravels, which on Mount Greenland occur 4900 feet above sea-level; they may be the gravels of rivers, that flowed in part across land now sunk beneath the sea.

The Pliocene system includes the Wanganui beds, which occupy the basin of the Wanganui River, to the

north of Cook Strait, between the Ruahine Range on the east and Mount Egmont on the west. The beds consist of very fine clays, which contain numerous fossils, often well preserved in nodular concretions. It is also developed at Taranaki, Poverty Bay, and Napier on Hawke's Bay.

The Pleistocene system begins with a series of deposits in the South Island, which indicate a great extension of the New Zealand glaciers in Lower Pleistocene times. Some of the glacial beds at Cascade Point occur at sea-level, interstratified with marine beach deposits. The western glaciers, which are now confined to the valleys on the flanks of the Alps, then spread out in wide sheets over what is now the coastal plain of Westland. On the eastern side of the Alps the former extent of the glaciers appears to have been considerably exaggerated. In a traverse across the island from Christchurch and Greymouth, I failed to recognise evidence of glacial action in localities where it has been claimed to exist, upon the Canterbury Plains and in the eastern foot-hills of the Southern Alps. But south of Dunedin, at the mouth of the Taieri River, there are some boulder beds that have been described as glacial moraines. The evidence at present appears doubtful. The Pleistocene swamp deposits are full of interest, from their rich collections of the bones of the Moa and other giant extinct birds.

There is no trace of the early existence of man in New Zealand. The Maori kitchen-middens and their stone tools occur only in deposits of very recent age.

The Cainozoic volcanic history of New Zealand begins in the Oligocene, to which period doubtless belong the volcanic rocks of Dunedin and Banks Peninsula. The Dunedin rocks, including tephrites, kenytes, and bostonites, have been recently described by Dr. Marshall.

The Miocene volcanic system is mainly developed in the North Island, and includes the andesites and rhyolites of the Thames goldfields and of the Taupo volcanic district. The rhyolites of Tarawera, Rotorua, and the Thames Peninsula, and the hornblende-andesites of Mount Ruapehu and Mount Egmont are assigned by Hutton to the Pliocene. But the volcanic eruptions, to which are due so many of the chief geographical features of the Taupo district, are of Pliocene age.

The only complete geological map of New Zealand is that published by Sir James Hector.[1] The main information about the geology of New Zealand is contained in the "Reports of Geological Exploration," issued by the Geological Survey of New Zealand, and in the annual reports of the Mines Department, which deal more especially with the economic geology. A brief sketch of the geological history of New Zealand has been given by Hutton in *Trans. New Zealand Inst.* vol. xxxii. 1899, pp. 159-183. A bibliography of the chief literature has been compiled by A. Hamilton, *Trans. New Zealand Inst.* vol. xxv. 1903, pp. 489-546.

14. The Climate of New Zealand

Considering the length of New Zealand from north to south, ranging over 13° of latitude, the climate of the whole country is remarkably uniform, the difference in mean temperature between Auckland and Dunedin, over 600 miles apart, being only 8·7°. The climate is also unusually equable, the annual local ranges in temperature being small. For example, the mean annual variation at Dunedin is only from 40·5° to 57·2°, and the extreme range known is only 53°; and the mean temperature for

[1] "Reports of Geological Explorations," 1883-84, No. 16, 1884.

the whole colony varies only from 48° in the winter to 63° in the summer. And for the latitude, the temperature of New Zealand as a whole is low. New Zealand owes these climatic conditions to the high mountains which traverse it, to its insular position, to the cool ocean currents which wash its shores, and to the small part of the surface occupied by open plains exposed to the summer heat. New Zealand is remarkably subject to sudden change in temperature and violent gales, due to its exposed position across the line of the "roaring forties"; for those strong west winds sweep against it after a long passage across the Southern Ocean. The prevalent direction of the winds is from the west, so the country on the western coasts has a heavy rainfall. The highest record is at the south-western corner of the South Island, where, at Puysegur Point, the average rainfall is 228 inches. The rainfall is above 100 inches all along the southern part of the western coast, as far north as Greymouth. The eastern coast has the lowest rainfall; it is below 30 inches on the Canterbury Plains, and in one locality, Clyde, the average is 15 inches. The hills around Otago and Banks Peninsula near Christchurch, owing to their altitude, have a rainfall of nearly 40 inches. In the North Island the highest rainfall is at Mount Egmont, 112 inches; elsewhere the heaviest rains are upon the mountains of the Coromandel Peninsula, and upon the mountain chain on the eastern side of the island, from Wellington to East Cape.

The weather of New Zealand, as a whole, is governed by the passage of a series of cyclones, generally moving from west-south-west to east-south-east, along a track which lies to the south of the South Island. The general course of these cyclones is considered in the chapter on the climate of Australia, the charts accom-

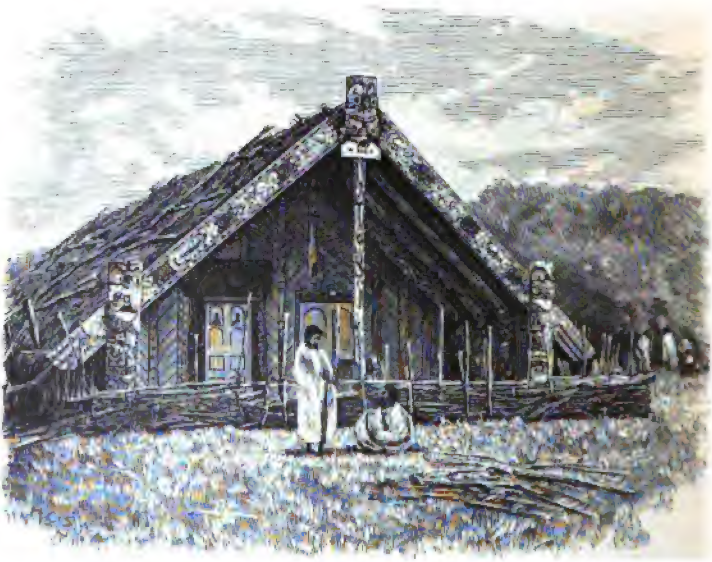
panying which illustrate the course of the cyclones before they reach New Zealand. The hot dry winds of the Canterbury Plains have given rise to considerable discussion. These winds come from the Tasman Sea, during their passage across which they become charged with moisture; this is precipitated when the air strikes against the cold summits of the Southern Alps, and the condensation of the aqueous vapour renders the latent heat sensible, and thus the air sweeps down from the mountains on to the plains, not only dry, but warmed by its desiccation.

15. The Maoris

The Maoris are one of the finest and most interesting of the savage races of mankind. They belong to the family of the Brown Polynesians, but the race itself is extremely mixed. In a group of pure-bred Maoris one can recognise variations in physiognomy, including the Mongolian, Melanesian, as well as Polynesian types. One of the boatmen on the Wanganui steamers so strikingly resembles a Japanese that—though he is a true Maori—I was told that he was invariably mistaken by strangers for a Japanese. Many of the Maoris of Rotorua have strongly the characteristics of Melanesians. This mixture of races is not surprising, since the Maoris have entered New Zealand from the Pacific Islands at different times and by various routes. They were in the habit of making long canoe expeditions, during which they, no doubt, visited all the islands of the central and western Pacific.

The Maoris are, in the main, unquestionably a Polynesian race, which appears to have entered the South Pacific from Malaysia, and comes from a black Caucasian

stock. The main settlement of the existing Maori race in New Zealand appears to date from four hundred to six hundred years ago. They came from an island, which their legends call Hawaiki,[1] and is generally regarded as Rarotonga. According to Percy Smith, the Rarotongans began long canoe voyages across the Pacific about the



A MAORI DWELLING.

year 650; they probably explored the whole ocean from Hawaii to New Zealand, and even far to the south of it, and from Melanesia through the Paumotus, as far east as Easter Island. The main settlement in New Zealand took place about 1350. This band of emigrants

[1] The traditions of the pre-New Zealand history of the Maoris are well given in S. Percy Smith's *Hawaiki: the Original Home of the Maori*, 2nd edition. Christchurch, 1904.

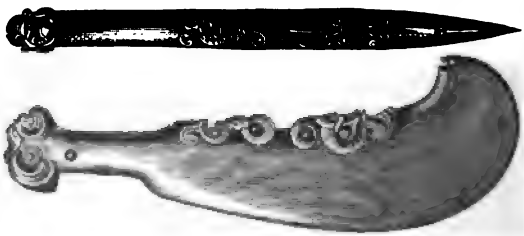
found the country already occupied by earlier Polynesian settlers; and, according to the high authority of Mr. A. Hamilton, of the Wellington Museum, some of the early settlers were probably Melanesian. The Maoris promptly either exterminated or absorbed their predecessors. They formed their largest settlements in the North Island. The search for the green-stone, which they used for their stone tools and weapons, led to their occupation of the western coast of the South Island. They also formed settlements on the eastern coast of the South Island, one of their chief towns being at Otago.

According to the list made by Colenso in 1865, the Maoris may be divided into 34 tribes, in addition to the Morioris of the Chatham Islands. The tribes are again divided into many sub-tribes. It has been maintained that it would have been impossible for so many tribes, each with its local dialect and peculiar customs, to have developed in so short a time; and therefore, by some authors, the Maori occupation has been regarded as dating from 3000 years ago. But the Maori traditions of the emigration are very distinct; the people count back their ancestry to the pioneer settlers; and the records of tribes in so many different districts agree so closely as to the number of previous generations in New Zealand, that the Maori experts are almost unanimous as to their arrival only a few centuries ago.

The Maoris were, no doubt, contemporary with the Moa, and they used them, especially the birds of the genus *Pachyormys*, as one of their chief supplies of food; for the heads and necks, with the muscles and tendons still preserved, have been found in considerable numbers in the middens outside the old Maori settlements.

The Maoris are physically a powerful race, with long black hair, which is either wavy or straight. They had

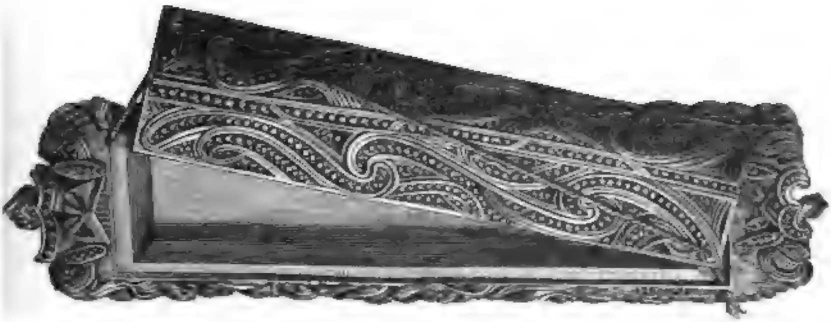
no knowledge of metals, the whole of their tools and weapons being made of stone. The most valuable material used was the "green-stone" (a pseudo-jade or nephrite, found in the South Island), and flakes of obsidian and quartzite. Their green-stone weapons are amongst the finest of known stone tools. Their clothes were made mainly from the New Zealand flax (*Phormium*), and cloaks of dogskin. The people were very skilled in making baskets, fishing lines, fish snares, and rat snares. They were most accomplished builders of wooden houses, and they made large sea-going canoes. Their houses



WAR CLUB OF NEW ZEALAND.

were well built and elaborately carved, as were also their wooden chests and boxes. The chief personal decorations were feathers, dyes, coloured earths, and elaborate tattooing. Personal property and houses belonged to individuals, while wild produce was common. Tribes were divided into freemen and slaves, the chief of the tribe being also its head priest. The tribes believed in fetish, and practised sacramental cannibalism. The tribes were always engaged in blood feuds and wars. They built fortified "pas" on the summit of the hills. After the introduction of guns and gunpowder by European traders, their method of warfare was modified, and the forts defended by elaborate rifle-pits.

In 1840 the Maori population was estimated at about 120,000, but the use of firearms in war soon reduced their numbers, and by 1874 they were only 45,000. But the decrease appears now to have been checked, as their number, according to the census of 1902, was 43,143, an increase of 2000 on the census of 1886. The Maoris show great capacity for education; some of them practise as lawyers in the towns, and they return four representatives to Parliament. Their lands



CARVED NEW ZEALAND CHEST.

are preserved to them by special legislation, and are managed by State trustees; so that they cannot themselves alienate their estates. The Maoris are the ground landlords of some of the west coast towns of the South Island, and many of them are wealthy. In February 1901 the Maoris held the following property:—317,436 sheep, 56,943 cattle, 57,642 pigs, and they had under crop 7370 acres of potatoes, 3724 acres of wheat, and 5000 acres of maize.

16. Economic Geography

1. *Pastoral and Agricultural Industries.*—The most important source of wealth in New Zealand is the pastoral

industry. The mild, wet climate stimulates the growth both of native vegetation and of the richer introduced European grasses, which are nourishing foods for sheep and cattle.

Wool has been the most valuable article of export, the amount in 1903 being over 155,000,000 lbs., worth £4,041,271. During recent years the invention of cheap processes for the transport of frozen meat has further increased the importance of sheep-raising; and the breed of sheep is being altered to secure a high quality of meat as well as of wool. The total amount of frozen meat exported in 1903 was 2,378,650 lbs., valued at £3,197,043. The number of sheep in the different provinces was as follows:—

Canterbury	4,176,236
Hawke's Bay	3,116,673
Wellington	3,793,518
Otago	3,632,765
Auckland	2,086,789
Marlborough	826,474
Nelson	857,142
Taranaki	436,851
Westland	28,105

In April 1904 the total number was 18,000,000. Cattle-raising has become of increasing importance owing to the establishment of dairy farms and butter factories, and the export of butter to Europe. The number of cattle in 1904 was 1,593,547. Many of the old sheep runs and cattle stations are being divided into small farms, which yield a much greater wealth to the State. The products exported in 1903 were 285,106 cwts. of butter and 74,780 cwts. of cheese.

Agriculture is still of secondary importance. The following table shows the areas and products of the chief crops for the year ending March 1904:—

Orchards	26,792	acres.	
Vineyards	750	,,	
Wheat	230,346	,,	789,654 bushels.
Oats	409,390	,,	12,109,237 ,,
Barley	34,681	,,	
Potatoes	31,778	,,	208,787 tons per acre, or 6·57 tons per acre.
Maize for grain	11,156	,,	

2. *Mining.*—The mineral industry practically dates from the discovery of the gold-diggings at Gabriel's Gully in Otago in 1861. The chief mining centres in Otago are alluvial, and have been greatly extended by the invention of the gold-dredge. At Reefton there are quartz mines; on the western coast, south of Greymouth, are alluvial deposits, from which the gold is obtained by sluicing the gravels and dredging the river beds and sea beaches. The most important gold reefs are in the Thames and Coromandel Goldfields, in the North Island; at the present time the chief mine there is at Waihi. The gold yield of New Zealand since the first discovery has been over 63 million pounds, and the mineral products for the year 1903 have been—

Gold	£2,037,831
Coal	762,858
Kauri gum	631,102
Silver and lead	91,497
Copper	123
Manganese	210
Scheelite	1,439
Miscellaneous and building stone	636,696

The chief coalfields are on the western coast of the South Island. The mines near Greymouth and Westport yield coal of exceptionally high quality for steam purposes. The mine at Seddonville, near Greymouth, is being worked by the State. Brown coal, or lignite, is

found in Otago and Auckland; but its value is greatly inferior to that of the Greymouth and Westport fields. The output of coal and lignite during 1903 amounted to 1,420,229 tons, and it was raised from 178 mines, employing 2852 men.

Amongst other mineral products are chromite, from

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A GOLD-DREDGE ON THE BULLER RIVER.

Dun Mountain, Nelson; platinum from the gravels of the South Island; Kauri gum, a fossil resin that exuded from the Kauri pines, and is dug from the site of fossil forests in the Auckland Province; it is used as an ornament and for the manufacture of varnish. Iron is widely distributed; but the only ores used are the black sands, found on the beaches on the western coast of the South Island,

and at Taranaki in the North Island. This magnetite ore is easily obtained by washing the sands, but its value is lessened by its inclusion of titanium. Green-stone is obtained in the rivers of Westland, and was extensively used by the Maoris for the manufacture of ornaments and weapons.

17. Timber and Manufactures

The timber industry is important, as the abundant forests yield large supplies of excellent wood. The two chief New Zealand pines are the red pine (*Dacrydium cupressinum*) and the white pine (*Podocarpus dacrydiodes*), the last of which is of great value for the manufacture of butter-boxes. The Kauri (*Dammara Australis*) is the most valuable timber, as its wood is remarkably durable. It is found in the Auckland Province. The pines are mainly worked on the western coast of the South Island.

The manufactures of New Zealand have hitherto been unimportant. Most of the produce is exported raw, and the factories are mainly confined to such articles as furniture and clothes, of which local production is necessary.

The infinite water power which is now running to waste in New Zealand will, no doubt, be employed later on for the generation of electricity and the development of the electro-chemical industries.

18. Political Geography

The population, according to the census of 1901, was 772,719, excluding the 43,112 Maoris and 31 Moriori[1]

[1] The Moriori are descendants of some of the pre-Maori occupants of New Zealand, and, according to Percy Smith, they migrated to the Chatham Isles from New Zealand about the year 1175.

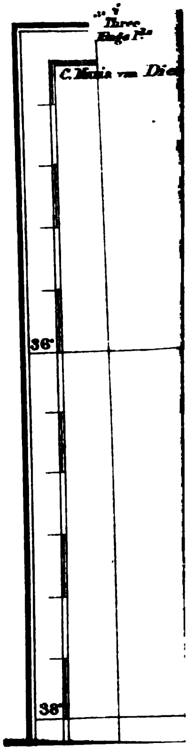
of the Chatham Islands, but inclusive of the 2857 Chinese.

The Government consists of a Governor appointed by the Crown, an Executive Council, and a Parliament of two Houses. The Legislative Council consists of 44 members, of whom those elected before 1891 are life members. The Council includes one Maori representative. The House of Representatives consists of 71 members, including four Maoris.

The revenue for the year ending March 31, 1904, was £7,434,022, and the expenditure £6,784,221. The national debt on that date was £57,522,215, involving an annual charge of £2,203,420.

The democratic party has been in power in New Zealand for many years, and the legislation has been of exceptionally advanced character. Under it, New Zealand has been brought to a high state of prosperity, and the confidence of the New Zealand population in their political experiments has been reaffirmed by the elections of December 1904. Apparently to the surprise of both parties, the late Mr. Seddon was returned to office with a greatly increased majority, and the practical annihilation of the Opposition.

The main land policy of the Government has been the breaking up of suitable cattle and sheep runs into farms, which support a denser population and produce greater agricultural wealth. The Government has power, under the Lands Settlement Consolidation Acts of 1900, 1901, 1904, compulsorily to repurchase large estates, at a price calculated by the owner's income-tax returns for the three previous years. Already 131 estates have been repurchased, at a total cost of nearly £3,000,000, and divided into farms, which are let at rents which bring in a return of from four to five per cent on the invested capital.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return of from four to five per cent on the invested capital.

Crown lands may be acquired by direct purchase, certain improvements being necessary before the transfer is valid; or by lease for twenty-five years, with the right of purchase after the first ten years; or by leases in perpetuity at a rent of four per cent on the price of the land. In all cases, excepting where the land is bought for cash or for small grazing areas, residence and improvements, such as clearing, drainage, fencing, etc., are compulsory. Pastoral country is let on lease for twenty-one years, the limit in size being that which will carry 20,000 sheep or 4000 cattle.

The defence forces of New Zealand consist of a small permanent garrison of artillery, engineers, and mounted rifles, the total number being 544, of whom 189 are officers. The main force consists of 12,634 volunteers, who are supplemented by rifle clubs and cadet corps, managed by the Education Department. Military drill is compulsory in all schools having more than twelve boys. The whole manhood of the State is thus being trained to the use of arms.

Education is compulsory between the ages of 7 and 14, and is secular and free. The chief educational institution is the New Zealand University, with colleges at Auckland, Wellington, Christchurch, and Dunedin. Owing to the competition between these colleges, the degrees are granted on the results of examinations conducted in England. The four university colleges specialise, however, in some respects: Dunedin having the chief Schools of Mines and Medicine; Christchurch, the chief School of Engineering and Agriculture. The educational system in the primary schools is very advanced in its methods, and the State has high educational ideals.

19. Towns in New Zealand

AMBERLEY (43° 2′ S. lat., 172° 45′ E. long.), in the county of Ashley, on the North Kowai River, 34 miles from Christchurch. It is the trading centre of an agricultural district on the Canterbury Plains. Population of town, 417; of county, 11,599.

ASHBURTON (43° 56′ S. lat., 171° 45′ E. long.), in the county of Ashburton and province of Canterbury, on the northern bank of the Ashburton River, 53 miles from Christchurch, on the railway line between Christchurch and Dunedin. It is the business centre of a rich agricultural district. Population of town, 6000; of the county, 13,664.

ASHURST, in the county of Oroua, province of Wellington, 97 miles from the city of Wellington, is the centre of an agricultural and dairying district. It is near the Manawatu Gorge. Population of town, 300; of county, 6450.

AUCKLAND (36° 50′ S. lat., 174° 50′ 40″ E. long.), in the provincial district of Auckland, on the southern shores of the Waitemata Harbour, a branch of the Hauraki Gulf. It is the largest city in New Zealand, and on one of the most beautiful estuaries. It is a great business city and port of call. It is the seat of the University, and has a fine Museum, rich in Maori remains. The Public Library includes the valuable library of Sir George Grey. The surrounding hills are old volcanoes with fine craters, such as Mount Eden; the most recent in eruption was probably Rangitoto on an island in the gulf. The population of the city and suburbs is 67,226.

BALCLUTHA (46° 12′ S. lat., 169° 41′ E. long.), in the county of Clutha, 52 miles south-west of Dunedin,

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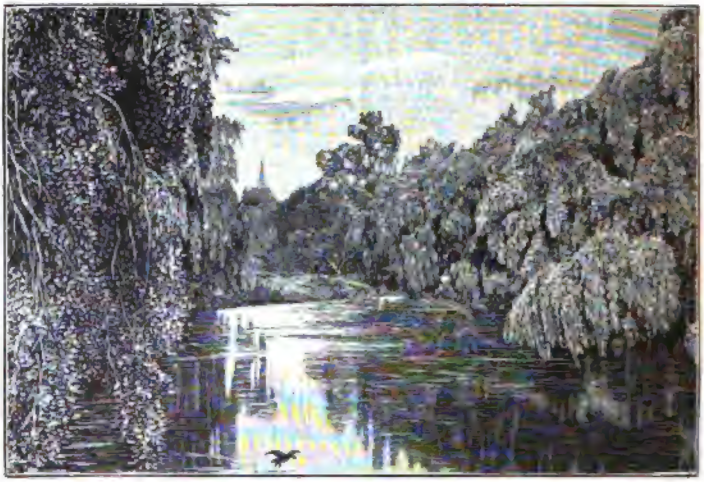
AUCKLAND, N.Z. VIEW OF WHARVES AND CITY FROM FLAG TOWER.

is an important railway and business centre. It is in a rich agricultural district, and is near the brown coal mines of Kaitangata. The population of the town is 1715.

BRUNNER (42° 22′ S. lat., 171° 34′ E. long.), in the county of Grey, 7 miles from Greymouth, on Grey River,



THE AVON AT CHRISTCHURCH.

is one of the chief coal-mining towns in New Zealand. Population of town, 1511; of district, 4972.

CHRISTCHURCH (43° 32′ 16″ S. lat., 172° 38′ 59″ E. long.), in the county of Selwyn, on the banks of the river Avon, is the capital of the Canterbury district. Its port is Lyttelton, 8 miles distant. It is the chief town in the northern part of South Island; has a University College; and the Museum contains the chief natural history and geological collection in New Zealand. It is the railway centre for the main line south to Dunedin

and Invercargill; west to Springfield for the overland route to Westland; and for the stations on the Canterbury Plains. Population of the city is about 50,000.

CROMWELL (45° 3′ S. lat., 169° 12′ E. long.), in the county of Vincent, is the chief town in the Wakatipu district, and of the gold-mining districts in the province. It is at the junction of the Clutha and Kawarau Rivers. Population of the town, 740; of the district, 4360.

DANNEVIRKE, originally a Danish settlement, in the county of Waipawa, 79 miles from Napier, on the railway line to Wellington. It is on the Manawatu River, and its chief industry is milling. Population of the town, 2314; of the district, 9496.

DUNEDIN (45° 52′ 11″ S. lat., 170° 31′ 7″ E. long.), on the south-western side of Otago Harbour, 9 miles from Port Chalmers, is the chief city in southern New Zealand, and the most important commercial centre in New Zealand. It is most picturesquely situated on the hills at the end of Otago Harbour. It was founded in 1848 by members of the Free Church of Scotland. Its prosperity was first established by the gold-mining of Otago. It is the seat of one of the chief colleges in New Zealand University, and the leading School of Mines, and the Medical School. The Museum has important specimens of the remains of the Moa and rare New Zealand birds. Population of the city and suburbs, 52,390.

ELTHAM, in the county of Hawera, on the main line between Wellington and New Plymouth. Population, 13,500.

FIELDING (40° 15′ S. lat., 175° 25′ E. long.), in the county of Oroua, near Oroua River, on the Wellington and New Plymouth line, is in a grazing and farming district, of which the population is 6786.

Gisborne (38° 45′ S. lat., 177° 59′ E. long.) is the capital of the Poverty Bay district, and 300 miles from Auckland. Hot springs occur at Nuhaka and Waipire. Population of the town, 2733; of the suburbs, 2435.

Greymouth (42° 25′ S. lat., 171° 9′ E. long)., in the county of Grey, at the mouth of the Grey River, 175 miles from Nelson, is the chief seaport on the western coast of the South Island. It is the centre of the railways of Westland, and is the port of the coal-fields of Brunner and the Grey Valley, and the goldfields of Reefton, Hokitika, and the alluvial deposits of Westland. Population of borough, 3746; county, 4972.

Invercargill (46° 35′ S. lat., 168° 50′ E. long.), on an estuary named New River Harbour, 17 miles inland from the Bluff, is the capital of Southland, and the principal town of the southern part of the Otago district. Its port, the "Bluff," is the southernmost port in New Zealand, and exports the frozen meat from the southern downs. The district is mostly pastoral, with some agriculture. Population of borough, 6215.

Lawrence (45° 55′ S. lat., 169° 43′ E. long.), in the county of Tuapeka, 60 miles south-west of Dunedin, is the mining town for the celebrated goldfield of Gabriel's Gully. Population of the borough, 1159; of the county, 6278.

Lyttelton (43° 36′ 42″ S. lat., 172° 44′ 17″ E. long.), a seaport town, beside Banks Peninsula, is the port of Christchurch. Its steamers connect the railway system of South Island with Wellington in the North Island. Population of borough, 4023.

Masterton (40° 58′ S. lat., 175° 31′ E. long.), on a plain 72 miles by rail from Wellington, is one of the largest inland towns in the North Island. Population of town, 3946; of county, 3123.

NAPIER (39° 29′ 12″ S. lat., 176° 55′ 12″ E. long.), the chief town in Hawke's Bay district, on Scinde Island Peninsula, on the estuary of the Esk and Tutækuri Rivers, is the chief port on the eastern coast of the North Island. A road goes inland to Taupo and Rotorua. It is the port of a large pastoral and farming district, and exports much timber from the forests on the Ruahine and Kaweka Ranges.

NELSON (41° 16′ 17″ S. lat., 173° 18′ 46″ E. long.), in the county of Waimea, on the shores of a small harbour at the bottom of Blind Bay, is the chief port on the southern shore of Cook's Strait. A railway goes inland to Motupiko, whence a road crosses to the Buller Valley and Westport. The hills to the east yield copper and chrome ores. The chief local industry is fruit-growing and farming. The population of Nelson is 7000.

NEW PLYMOUTH (39° 3′ 35″ S. lat., 174°·4′ 58″ E. long.), the chief town in the district of Taranaki, on the western coast of North Island, is near the foot of Mount Egmont. It is 120 miles south-west of Auckland, and is the chief outlet for stock from the Waimate Plains. It is the port of a rich dairying and agricultural district. Population of town and suburbs, about 6000 ; of province, 37,842.

OAMARU (45° 6′ S. lat., 171° 1′ E. long.) is the most northern town in Otago, 78 miles from Dunedin, and 152 miles from Christchurch. It is in a rich farming district, and in the neighbourhood are the quarries of Oamaru limestone, one of the chief New Zealand building stones. The port is protected by a breakwater. Population of borough, 4853 ; of county, 9086.

PAEROA, in the county of Ohinemuri, 22 miles from Thames on the Ohinemuri River, is the centre for the

goldfields of Karangahake, Owharoa, and Komata, and an extensive agricultural, pastoral, and dairy-farming district. The population of the town is 1682; of the district, 9975.

PALMERSTON NORTH (40° 21′ S. lat., 175° 38′ E. long.), in the county of Oroua, is an important station on the Wellington-New Plymouth Railway. It is 88 miles from Wellington, 8 miles from the Manawatu Gorge. The district is agricultural. Population of the town is 6534; of the district, 6788.

RIVERTON (46° 20′ S. lat., 168° E. long.), on a fine estuary formed by the Aparima or Jacob's River, and the Paurakino. It is connected by rail to the gold-mining centre Orepuki, and the coal-producing centre of Nightcaps. Population of the town is 815; of the district, 7988.

STRATFORD (39° 75′ S. lat., 174° 25′ E. long., 1012 feet above sea-level), 20 miles from New Plymouth, and at the foot of Mount Egmont (8260 ft.). The district is pastoral. Population of town is 2027; of county, 5081.

TAIERI (46° S. lat., 170° 14′ E. long.), in the county of Otago, 6 miles south of Dunedin, is on some plains beside the Taieri River, and is the centre of a rich farming district. There are also some gold-mining and brown coal-mining. Population of the town, 1500; of the district, 7500.

TAURANGA (37° 34′ 30″ S. lat., 176° 10′ 30″ E. long.), in the county of Tauranga, 84 miles from Thames, on an inlet of the Bay of Plenty, is the chief centre of the agricultural and pastoral districts of the Bay of Plenty. Population of the town is 1050; of the district, 11,250.

THAMES (37° 5′ S. lat., 175° 32′ E. long.), in the

county of Thames, 40 miles south-east of Auckland, is on the Firth of Thames, and is one of the mining centres of the Thames Goldfields. Population of the town is 4004; of the district, 5043.

TIMARU (44° 23′ S. lat., 171° 17′ 20″ E. long.), the chief town in South Canterbury, at the south-western end of the Ninety-Mile Beach, 10 miles north of the Pareora River, is the port and centre for the southern part of the Canterbury Plains. It is 100 miles from Christchurch, and 131 miles from Dunedin. Population of town is 6421.

WAIMATE (44° 46′ S. lat., 171° 8′ E. long.), in the county of Waimate, on the Waimate Creek, 130 miles from Christchurch. It is the starting-point of the Gorge Railway, running to Waihao Downs. The industries are roller flour-mills and steam saw-mills. Population of the town, 1359; of the district, 5653.

WANGANUI (39° 56′ 48″ S. lat., 175° 5′ 50″ E. long.) is situated on the northern bank of the Wanganui River, 4 miles from its mouth. It is 134 miles north of Wellington. It is the commercial centre of the Wanganui Valley, and steamers ascend the river, working up the rapids by means of ropes laid on the bed of the river. It is on the railway from New Plymouth to Wellington. The district is both agricultural and pastoral, and has large exports of cattle, sheep, grain, and wool. Population of the town, 7331; of district, 10,000.

WELLINGTON (41° 16′ 25″ S. lat., 174° 47′ 25″ E. long.), in the county of Hutt, is the capital of New Zealand. It stands on the shores of Port Nicholson, an inlet off Cook's Strait. It is the principal port of call in New Zealand. It was founded in 1840, and is now the seat of the Government and of the Government Departments. It has the Parliament House, which, like

many of the chief buildings, is made of wood as a precaution against the occasional earthquakes. The Colonial Museum has rich stores of geological material collected by the Geological Survey of New Zealand. It is the starting-point of two railway lines to the inland towns

NIKAU PALMS, THE HUTT, WELLINGTON.

and back country. The census population in 1901 was 43,638; of the suburbs, 5706.

Westport (41° 31′ S. lat., 168° 50′ E. long.), in the county of Buller, on the Buller River, 40 miles north-west of Greymouth, is the port for the gold- and coal-mining districts of the Buller Valley, etc., and for the

coal-fields of Mount Rockfort. It has the best harbour on the western coast of South Island. Population of the town is 2921; of district, 4867.

WHANGAREI (35° 51′ S. lat., 174° 31′ E. long.), in the county of Whangarei, on the river Hotea, 20 miles from its mouth, is 80 miles north of Auckland. The brown coal-measures occur in the district at Hikurangi and Ngunguru. Medicinal springs occur at Kamo. The district is mainly agricultural. Population of the town, 1700; of the district, 7000.

For New Zealand, the chief official publications are:—

Statistics of the Colony of New Zealand, and the *Official Year-Book*, both issued annually; also the Reports of the Departments of Lands and Survey, a work of high geographical value. Most of the mining and geological information is in the *Papers and Reports relating to Minerals and Mining*, issued annually by the Mines Department. Formerly most of this information was issued in the Reports on New Zealand Geology issued by the Geological Survey.

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INDEX

), 99,

S. W.),

, 16
;

aland,

" 173
Aus-

456
184

277,

288

99

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